MICROSCOPIC EXAMINATION OF COTTON SAMPLES BEFORE AND AFTER AFIS ANALYSIS

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Abstract

The Advanced Fiber Information System (AFIS) evaluates fiber samples by measuring properties such as length, circularity, perimeter and nep count. Measurements of fiber parameters of four different fiber varieties that had previously been evaluated for white speck nep formation were carried out. Resulting values were examined to determine whether any AFIS measurements could predict white speck content of the samples that related to those values determined by image analysis on dyed fabrics. The fiber samples were also examined microscopically to determine whether fiber bundles initially present in the samples were separated and measured by the AFIS system. After evaluation, no AFIS data could be found to directly correlate with values found by image analysis. Scanning electron microscopy showed that fiber bundles initially present in the samples could also be found in the samples after AFIS analysis, indicting that the AFIS separation system did not separate fibers from the fiber bundles, and thus, the measured values did not include measurements of the flat fibers in the defect bundles.

Introduction

Measurement of fiber properties that determine fiber quality is an ongoing task of the cotton industry. Such measurements determine the market value, marketability, and utility of harvested cotton lint(USDA-AMS). These properties are routinely measured in U.S. classing offices using the High Volume Instrumentation (HVI) system for measuring micronaire, fineness, length, length uniformity index, short fiber content, strength and elongation, and maturity ratio (Sasser). A more recently developed instrument, the Zellweger Uster Advanced Fiber Information System (AFIS), evaluates fiber samples by measuring similar parameters, but in different ways than does the HVI system. AFIS depends on airflow to separate and selectively measure fiber properties by an electro-optical system. It can measure fiber perimeter, cross-sectional area, lengths, diameters, and short fiber content, and calculate a micronaire analog. Thus, AFIS has been used to provide a measurement of mass fiber maturity (Thibodeaux). Measurement of individual fiber parameters as a representation of values of the whole fiber mass is dependent on the ability of the instrument to separate fiber bundles into individual components that can be detected and measured by the sensing system. This work was instigated to determine microscopically whether the AFIS system could separate bundles of extremely immature (undeveloped) fibers, those known to produce white specks, into individual fibers so that their measurements are accounted for in overall fiber quality determinations. A quick method for determining the presence and quantity of pre-white speck neps in raw cotton would be of great value. AFIS provides the possibility of providing such information if it can measure extremely immature fibers present in bundles. If compressed undeveloped fiber bundles pass through the system unseparated, then measurements of values such as fiber diameter, perimeter, micron-AFIS, and immature fiber fraction will not be representative of true values of the sample. Any extrapolation of these values to white-speck propensity may not represent the true likelihood of the sample to produce white specks.

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Materials and Methods

Samples for this study were grown under irrigated conditions in a field in the San Joaquin Valley in California, and included a commercial Deltapine Upland (DP-90), a Mississippi hybrid (ST-825), and two Acalas, (EA-C 30, early maturing, and EA-C 32, a Prema). Samples have previously been evaluated from bale to fabric for white speck defects, and have been rated for white dye defects using image analysis techniques.

Fiber properties of samples were evaluated using two AFIS systems, an AFIS Version 2 with L/D/F/M Module, and an AFIS Version 4.12, using both the MultiData Module, and the L/F/M, R&D Version. Fiber property measurements from the two instruments were correlated. Samples were retrieved and saved after passing through the instruments.

Fiber bundle defects were separated from each sample both before and after passing through AFIS. These were mounted and coated for scanning electron microscopy (SEM) and examined at both low and high magnifications. Separated trash was also examined.

Results and Discussion

Although measured fiber properties were analyzed and compared, the thrust of this experiment was to determine whether the AFIS system separates fiber bundles that have been present in samples since harvesting, and whether these fiber parameters are reflected in the AFIS data . Measurement of the presence of white speck-producing defects in fiber lots, or evaluating the probability of samples to produce white speck fabrics is of great importance in evaluating quality of fiber lots. Separation of bundles of undeveloped fibers into individual fibers so that they could be blended with more mature fibers, or more particularly, so that their presence in fiber lots can be determined would provide valuable methodology to the textile industry. If undeveloped fiber bundles pass through the AFIS system unseparated, and thus are not measured, presence of these fibers in the lot would not be noted, and the resulting data may not be truly representative of the sample.

When bulk samples were visually compared before and after passing through the AFIS system, their appearance was quite different. Samples that had been analyzed were fluffy, while before passing through the instrument they were compact. However, clumps of unseparated fibers were apparent in both samples. When samples of the four special grown fibers, collected from the chute area during processing, were examined by SEM, fiber defects were easily found. Using darkfield light microscopy(Goynes), white speck-forming defects were confirmed. Clumped fibers were removed from both samples for the four varieties, and studied microscopically. SEM showed clumps from the pre-AFIS sample to be tangled, flat fibers without secondary wall development. These structures were the same as were found in these samples when undyed defects in dyed yarns and fabrics were examined. They have been shown to be the major source of white specks. Examination of fiber clumps or defects taken from samples from all four varieties after AFIS evaluation showed the presence of the same clumped fiber bundles. The fiber bundles found were not separated by AFIS processing, and thus values of their property parameters were not accounted for in the AFIS data. While defects were easily found in all samples, they were much more apparent in EAC 32, and STV 825.

In the total evaluation of these four varieties it was found that they could be ranked both by visual ratings, and by image analysis of dyed fabrics as to white speck content (Goynes). By these ratings, the EA-C30 sample had the least number of white defects, the DP-90 ranked second best, STV-825 ranked third, and the EA-C32 had the highest number of white defects. This ranking is shown in Table IB. Table IA compares results of AFIS analyses on the two AFIS systems used. In the table the samples are listed in the order of increasing white speck content as measured on dyed samples by image analysis.

From the table it can be seen that values obtained from the two AFIS systems agree closely in some measurements, while in others values are quite different. Area and perimeter values are in good general agreement. However, values for immature fiber fraction (IFF) and fine fiber fraction (FFF) are quite different. Although the trend of increasing values of IFF as measured by the older system (Version 2.0) generally matches the increasing nep count as measured by image analysis, image analysis measured values for the two worst samples (STV 825 and EAC 32) are three to four times as great as are those for the two best samples (EAC 30 and DP 90). These broad differences are not reflected in IFF values. The same is true for values of the fine fiber fraction (FFF). Values for fiber area, or perimeter also do not predict the extreme differences found in the samples by image analysis. Similarly, values for THETA and Micron AFIS predict the extreme differences in white speck imperfections among these four varieties. Nep count (ct/gm) does indicate that the EAC 30 sample should have the least number of neps, but these values too, do not show the extreme differences found by image analysis. These differences in measured values may be partially due to differences in what the two systems measure. Neps as measured by AFIS included all neps (undeveloped fiber bundles, seedcoat fragments, and tangled mature fibers), while image analysis only measures those neps that form white speck defects.

If AFIS data is to be used to predict white speck formation, the separation system of the instrument must be able to disentangle bundles of fibers. While loosely tangled mature fibers may separate more readily, thin, flat ribbon-like fibers are more closely attached, often looping around each other. In many cases they are also "sticky". These factors make "white speck" defects more difficult to separate.

Summary

Samples whose white speck content had previously been measured on dyed fibers and fabrics by Image Analysis were examined by two AFIS systems to determine whether any fiber quality parameter measured by AFIS produced values consistent with those measured by Image Analysis. Scanning electron microscopy (SEM) was used to examine samples both before and after AFIS analysis to determine whether fiber bundle defects passed through the AFIS system without separation. These examinations confirmed that the fibers in these fiber neps before AFIS analysis had the same flat, ribbon-like structure found in fibers on undeveloped seed (motes), and in white speck defects on dyed fabrics.. After the samples were AFIS analyzed, fiber bundles were still obvious in the fluffy samples. Microscopical examinations of these defects showed that they were the same type fibers found in samples before AFIS analysis, and they were wrapped and twisted together so that they could not be analyzed as individual fibers.

Some AFIS values, such as immature fiber fraction showed trends indicating that some fiber varieties may produce more white speck defects than others, however none showed the great differences in white speck content as was found by Image analysis of dyed fabrics from these fibers. While AFIS does indicate immature fiber content of a measured sample, it does not appear from these experiments that any AFIS measurements correspond directly to white speck defect content of a sample. This appears to be due to the lack of separation of white speck fiber bundles.

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able IA. Comparison of Data from Two AFIS Instruments (AFIS Module 2.0 and AFIS Module 4.12).

SAMPLE	IFF	FFF	A(n) μm^2	PERI M	THETA	MICRON AFIS	NEP μm	Ct/g
EAC 30								
(2.0)	12.0	15.4	109.4	57.6	0.516	4.349		
(4.12)	9.7	9.6	105.5	53.7	0.477		568	358
DP 90								
(2.0)	16.0	16.9	107.3	54.1	0.460	3.775		
(4.12)	9.6	8.0	107.5	55.7	0.449		551	471
STV 825								
(2.0)	15.9	11.8	116.2	57.1	0.448	3.909		
(4.12)	9.7	5.4	110.8	57.5	0.435		551	649
EAC 32								
(2.0)	17.5	26.7	93.1	50.4	0.460	3.387		
(4.12)	10.8	16.6	98.5	52.7	0.453		550	573

Table IB. Image Analysis.

	NEP	
SAMPLE	%White	$12in^2$
EAC 30	0.014	
(2.0)		10.0
(4.12)		
DP 90	0.018	
(2.0)		14.1
(4.12)		
STV 825	0.049	
(2.0)		42.4
(4.12)		
EAC 32	0.062	44.9
(2.0)		
(4.12)		