



## Fiber Fineness and Maturity as Measured by Image Analysis, AFIS, MANTIS and HVI Methods in Some Egyptian and American Cotton Cultivars

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### ABSTRACT

Fiber samples for eight Egyptian and eight American cotton cultivars were measured by Image Analysis, AFIS, Mantis and HVI methods in the laboratories of the SRRC, ARS, New Orleans, Louisiana, USA. Fiber fineness and maturity measurements, i.e. cross section area, perimeter, diameter, circulatory and micronaire value, measured by image analysis technique, AFIS, Mantis and HVI methods proved to be significantly affected by cotton cultivar, whether between or within the Egyptian and the American cotton cvs. (*G. barbadense*) are finer than the American cotton cvs. (*G. hirsutum*). Results indicated that the Egyptian cotton cvs. exhibited lower values of cross-section area ( $107.6\mu^2$ ), diameter ( $11.5\mu$ ), perimeter ( $49.3\mu$ ) and micronaire reading (3.4) than the American ones, being 158.1, 13.7, 58.8 and 4.9 for cross section area, diameter perimeter and micronaire reading, respectively. On the other hand, the American cotton cvs. showed slightly higher values of circulatory (0.59) than the Egyptian cotton cultivars (0.57). Within the Egyptian cultivars, Giza 45 proved to be the finest cotton cv., while Giza 80 was the coarsest one. Whereas in the American cotton cvs. Stoneville 825 was the finest cultivar and Lengupa was coarsest one. The relationships between the above methods were studied.

### Introduction

Using the new techniques and instrumentation such as HVI, AFIS, Image Analysis and Mantis in measuring fiber properties enable to get accurate measurements for each fiber property. Moreover, comparing the measurements which are obtained from the different instrument and techniques provides good and important information about the accuracy of each and the magnitude of the differences between these measurements. Nawar (1990) found that the mean values of ribbon width for 19 of some imported cotton cultivars cultivated in Egypt, ranged between 10.31 and 16.90 micron with the gross mean of 13.09 micron. Boylston *et al.* (1993) found that fiber circularity results from Image analysis and AFIS agreed in some sample and disagreed in the others. On the other hand, Xu *et al.* (1993) stated that cotton maturity shows a high correlation with cotton roundness. Thibodeaux *et al.* (1993) found that AFIS is an excellent tool for rapidly determining the quality of cotton, MICRONAFIS correlates well with Micronaire.

### Material and Methods

Samples of cotton fibers were obtained from the field experiments of the Egyptian cotton cultivars (*G. barbadense* L.) namely; Giza 45, Giza 76, Giza 77, Giza 70, Giza 75, Giza 81, Giza 80 and Dendera grown in Giza, Egypt, during the two successive seasons of

1990 and 1991 after mixing the two seasons, to be compared to the American cotton cultivars (*G. hirsutum* L.) namely; Stoneville 213, Acala SJ5, Deltapine 61, Western Storm Proof, an AMS standard (cultivar unknown), Legupa and Lankert grown in Southern Regional Research Center, USDA, ARS, New Orleans, Louisiana, USA.

Four instruments were used for determining fiber fineness and maturity as follows:

1. HVI was used to determine Micronaire reading.
2. Advanced Fiber Information System (AFIS) was used to obtain the following measurements; Circularity (Theta), fine fiber fraction (FFF), immature fiber fraction (IFF), cross-sectional area (Area), Diameter (D) and AFIS calculated micronaire (MICRONAFIS), (Hinojosa *et al.*, 1993).
3. Mantis was used to determine fiber ribbon width (RW).
4. Image Analysis was used to determine area, perimeter, circularity and diameter (Boylston *et al.*, 1991).

All fiber tests were carried out in the laboratories of the SRRC, ARS, New Orleans, Louisiana, USA, at a constant relative humidity of  $65\% \pm 2$  and temperature of  $70 \pm 2^\circ\text{C}$ .

## Results and Discussion

### A. Fiber fineness and maturity measured by image analysis, AFIS, Mantis and HVI methods

Results of fiber fineness and maturity measured by Image analysis, AFIS, Mantis and HVI methods are shown in Table 1.

Comparing HVI micronaire and MICRONAFIS, it could be noticed that the mean value of the HVI micronaire was higher than the MICRONAFIS value by 0.1 (from 0.1 to 0.6 unit) in Egyptian cotton cultivars, and by 0.2 (from 0.1 to 0.7 unit) in American cotton cultivars. These results cleared that the HVI micronaire and MICRONAFIS values did not clear any definite trend within the Egyptian and American cotton cultivars.

The results show that the Mantis ribbon width values were the highest, whereas the AFIS diameter values were the lowest. In this respect the values did not show any tendency to be higher or lower for different cotton cultivars. In conclusion, using the optical system in Mantis indicated that the projected fiber ribbon width for the American cotton cultivars are larger than for Egyptian cotton cultivars.

Regarding the image area and AFIS area, results indicated that the American cotton cultivars exhibit larger cross-sectional areas as measured by AFIS. Also, the results of area by Image analysis and AFIS agreed in some samples and disagreed in the others.

The Image circularity values exhibited higher values than the AFIS circularity in Egyptian cotton cultivars, being 0.57 and 0.48 as well as in American cotton cultivars, being 0.59 and 0.52; respectively. It could be noticed considerable differences between circularity measurements obtained from Image or AFIS methods.

Regarding immature fiber fraction (IFF) by AFIS, which means the percent of fibers with values of circularity less than 0.25. it could be noticed that the immature cultivars had the lowest values of micronaire and circularity. This study clears the importance of AFIS in studying the immature fiber fraction.

As for fine fiber fraction (FFF) by AFIS, which means the percent of fibers with cross-sectional area less than  $60\mu^2$ , results indicate that the Egyptian cottons showed was significant and positive in the American cotton cultivars being 0.790.

Image area showed highly significant positive correlation with Image diameter, and significant positive correlation with Image perimeter in the Egyptian cotton cultivars only, being 1.000 and 0.738, respectively.

The other relations not mentioned above did not show any definite trend or had insignificant "r" values.

### Conclusion

the larger values of FFF. It could be noticed that the immature cultivar had the highest values of fine and immature fiber fraction by AFIS. AFIS is an excellent tool for rapidly determining fiber maturity bedside the others cotton quality parameters. The results from Image analysis and AFIS agreed in some cultivars and disagreed the others.

### B. Relationship between fiber fineness and maturity parameters measured by Image analysis, AFIS, Mantis and HVI methods

Simple correlation coefficients between fiber fineness and maturity parameters measured by Image analysis, AFIS, Mantis and HVI methods for the Egyptian and American are shown in Tables 2 and 3.

AFIS diameter by number shows significant positive correlation with AFIS area, Image perimeter and Mantis ribbon width in the Egyptian cotton cultivars, being 0.786, 0.738 and 0.755, respectively while in American cotton cultivars it showed highly significant positive correlation with AFIS area, being 0.886.

AFIS circularity (degree of thickening) showed highly significant negative correlation with AFIS-IFF in the Egyptian cotton cultivars, being -0.988, while in American cotton cultivars it showed significant negative correlation only in this respect, being -0.731. AFIS circularity showed highly significant positive correlation with MICRONAFIS, being 0.946 and 0.952 in the Egyptian and American cotton cultivars; respectively. AFIS circularity and Image circularity had highly positive correlation only in American cotton cultivars, being 0.921.

AFIS-IFF (immature fiber fraction) showed highly significant negative correlation with MICRONAFIS in the Egyptian cotton cultivars, being -0.934, while it was a significant negative correlation in this respect in American cotton cultivars, being -0.755. AFIS-IFF showed significant positive correlation with AFIS-FFF in the American cotton cultivars only, being 0.767.

AFIS area showed highly significant negative correlation with AFIS-FFF in the Egyptian and American cotton cultivars, being -0.905 and -0.970 respectively. It showed highly significant positive correlation with HVI-micronaire in the Egyptian cotton cultivars, being 0.921, whereas this relation

In conclusion there was insignificant relationship between average fiber diameter as measured by AFIS and HVI Micronaire reading or MICRONAFIS, this result disagreed with those obtained by Bragg and Wesinger (1993), they found that there was a significant relationship between average fiber diameter as measured by AFIS and Micronaire reading. Also, MICRONAFIS correlates well with micronaire reading in the American cotton cultivars only.

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**Table 1. Mean values of fiber fineness and maturity for Egyptian and American cotton cultivars measured by Image analysis, AFIS, Mantis and HVI methods.**

Cultivar	IMAGE ANALYSIS						AFIS			MANTIS	HVI	
	Area ( $\mu^2$ )	Perimeter ( $\mu$ )	Circularity ratio	Diameter ( $\mu$ )	Diameter ( $\mu$ )	Degree of thickening (circularity)	Immature fiber (%)	Cross- section area ( $\mu^2$ )	Fine fiber (%)	Micro n AFIS	Single fiber ( $\mu$ )	Micronaire Value (unit)
<b>Egyptian cultivars</b>												
Giza 45	85.7	44.0	0.57	10.3	9.7	0.54	12.5	87.5	29.2	3.9	11.5	3.3
Giza 76	92.0	44.9	0.58	10.7	9.6	0.52	13.1	83.9	31.7	3.6	10.8	3.1
Giza 70	101.6	48.4	0.57	11.2	9.3	0.48	17.2	78.3	39.0	3.1	11.5	3.3
Giza 77	105.4	48.1	0.59	11.4	9.4	0.44	19.6	75.1	41.5	2.7	11.0	2.8
Giza 75	123.6	51.7	0.59	12.4	10.6	0.49	15.1	89.0	28.5	3.5	12.4	3.6
Giza 81	113.1	48.9	0.61	11.8	10.8	0.51	15.1	92.3	27.4	3.7	12.8	3.7
Giza 80	139.8	56.2	0.58	13.1	11.4	0.46	17.7	90.8	30.3	3.3	12.7	3.7
Dandara	99.9	51.9	0.48	11.1	10.9	0.44	18.4	85.6	31.8	3.0	11.9	3.0
Mean	107.6**	49.3**	0.57**	11.5**	10.2**	0.48**	16.4**	85.3**	32.4**	3.3**	11.8**	3.4*
LSD (0.05)	1.73	0.51	0.02	0.17	0.44	0.03	1.28	4.62	3.84	0.39	0.35	0.12
<b>American cultivars</b>												
Stoneville 825	165.7	58.4	0.59	12.1	13.8	0.51	16.1	115.9	16.5	4.5	14.8	5.0
Stoneville 213	144.6	57.3	0.58	13.4	13.2	0.52	14.6	111.5	17.2	4.4	15.0	4.8
Acala SJ5	141.3	52.7	0.65	13.2	12.4	0.55	13.9	109.4	17.2	4.6	13.4	5.0
Deltapine 61	153.0	53.5	0.68	13.8	13.9	0.62	11.6	122.2	13.2	5.1	14.3	5.4
WSP	131.0	64.8	0.41	12.6	13.2	0.39	22.1	97.6	22.6	2.9	14.7	3.0
AMS	148.7	57.3	0.58	13.6	14.9	0.47	14.2	116.9	11.6	4.1	14.2	4.3
Lengupa	220.0	64.2	0.68	16.7	19.4	0.62	2.8	176.2	1.2	7.6	15.7	6.9
Lankart	160.5	62.2	0.54	14.1	15.1	0.48	11.9	122.8	11.5	4.4	15.2	5.1
Mean	158.1**	58.8**	0.59**	13.7**	14.5**	0.52**	13.4**	121.5**	13.9**	4.7**	14.7**	4.9**
LSD (0.05)	1.43	0.96	0.03	0.37	0.54	0.04	1.18	2.48	1.01	0.21	0.12	0.12
Mean	132.9**	54.0**	0.58**	12.6**	12.3**	0.50**	14.7**	103.4**	23.1**	4.0**	13.2**	4.1**
LSD (0.05)	1.55	0.75	0.03	0.28	0.48	0.03	1.20	3.61	2.74	0.30	0.25	0.12

\*, \*\* Significant and highly significant, respectively.

**Table 2. Simple correlation coefficients between fiber fineness and maturity parameters by using AFIS, Image analysis, Mantis and HVI methods in Egyptian cotton cultivars.**

Character	AFIS					Image analysis			Mantis	HVI	
	Circularity (φ)%	IFF %	Area μ <sup>2</sup>	FFF %	MICRON-AFIS	Area μ <sup>2</sup>	Perimeter μ	Circularity %	Diameter μ	Ribbon Width μ	Micronaire Value
AFIS diameter (n) μ	-0.156	0.108	0.786*	-0.524	0.143	0.429	0.738*	0.012	0.429	0.755*	0.712
AFIS circularity (□) %		-0.090	0.912**	0.927**	0.656**	0.935**	-0.818**	0.911**	0.931**	-0.704**	0.932**
AFIS immature fiber fraction (IFF) %			-0.300	-0.315	0.140	-0.280	-0.079	-0.323	-0.221	-0.072	-0.261
AFIS area (m <sup>2</sup> )				0.979**	0.786**	0.968**	-0.632**	0.980**	0.883**	-0.520*	0.959**
AFIS fine fiber fraction (FFF) %					0.703**	0.978**	-0.630**	0.988**	0.905**	-0.507*	0.964**
MICRONAFIS						0.699**	-0.389	0.731**	0.563*	-0.282	0.697**
Image analysis area (μ <sup>2</sup> )							-0.700**	0.988**	0.945**	-0.583*	0.994**
Image analysis perimeter (μ)								-0.630**	0.965**	-0.866**	-0.717**
Image analysis circularity (φ)									0.912**	-0.504*	0.975**
Image analysis diameter (μ)										-0.779**	0.954**
Mantis Ribbon width (μ)											0.616**

\*, \*\* Significant and highly significant, respectively.

**Table 3. Simple correlation coefficients between fiber fineness and maturity parameters by using AFIS, Image analysis, Mantis and HVI methods in American cotton cultivars.**

Character	AFIS					Image analysis			Mantis	HVI	
	Circularity (φ)%	IFF %	Area μ <sup>2</sup>	FFF %	MICRON-AFIS	Area μ <sup>2</sup>	Perimeter μ	Circularity %	Diameter μ	Ribbon width μ	Micronaire Value
AFIS diameter (n) μ	0.108	-0.575	0.886**	-0.921**	0.223	0.743*	0.343	0.224	0.743*	0.455	0.470
AFIS circularity(φ) %		-0.731*	0.431	-0.313	0.952**	0.419	-0.434	0.921**	0.431	0.132	0.807*
AFIS immature fiber fraction (IFF) %			-0.810*	0.767*	-0.755*	-0.548	0.204	-0.675	-0.881**	-0.238	-0.874**
AFIS area (μ <sup>2</sup> )				-0.970**	0.527	0.857**	0.144	0.434	0.857**	0.548	0.790*
AFIS fine fiber fraction (FFF) %					-0.439	-0.826**	-0.151	-0.370	-0.826**	-0.467	-0.693
MICRONAFIS						0.587	-0.307	0.939**	0.419	0.178	0.892**
Image analysis area (μ <sup>2</sup> )							-0.228	0.482	0.500	0.619	0.755*
Image analysis perimeter (μ)								-0.461	0.084	0.617	-0.084
Image analysis circularity (φ)									0.325	-0.060	0.739*
Image analysis diameter (μ)										0.452	0.671
Mantis Ribbon width (μ)											0.431

\*, \*\* Significant and highly significant, respectively.