MEASURING COTTON FIBER PERIMETER AND WALL THICKNESS OF SOME EGYPTIAN COTTON CULTIVARS BY USING MICROMAT TESTER

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Abstract

Fiber fineness is an important factor in yarn strength and uniformity properties that depend on the average number of fibers in the yarn cross section. Fiber perimeter is the variable that is of great effect on fiber tensile strength properties. New fineness equations depended on pl and ph measured by Micromat Tester were used to calculate fiber perimeter, diameter and wall thickness for some Egyptian cotton cultivars (Giza 45, Giza 88, Giza 85, Giza 86 and Giza 83). Significant correlation coefficients were found for all properties from Micromat Tester versus Image Analysis. The relation between the data from the two instruments was found to be quite strong (r = 0.9273, 0.9433 and 0.8856) for fiber perimeter, diameter and wall thickness; respectively. So the values of cotton fiber fineness (diameter and perimeter) as well as fiber maturity (wall thickness) could be determined rapidly by Micromat Tester. Success in this approach would provide an acceptable reference method, which is not currently available. The breeder and the spinner will get direct, accurate and fast determinations of biological fineness in terms of fiber perimeter or diameter and maturity in term of wall thickness.

INTRODUCTION

Fiber fineness has long been recognized as an important factor in yarn strength and uniformity properties that depend on the average number of fibers in the yarn cross section. Improvements in fiber quality can take many different forms of changes in length, strength, uniformity and fineness which are all needed to accommodate new techniques in cotton spinning (Deussen, 1992). However, direct determinations of biological fineness in terms of fiber diameter and wall thickness precluded by the high costs in both time and labor, the noncircular cross sections of dry cotton fibers and the high degree of variation in fiber fineness (Munro, 1987). Montalvo and Faught (1995) used new maturity and fineness equations as a function of FMT Pl and Ph readings and the data gave high correlation with NIR spectra. The typical range for wall thickness is 1.4 to 3.4 microns while the typical range for perimeter is 35 to 60 microns as calculated from fineness values (Ramey, 1982) and maturity ratio values (Lord and Hegs, 1988). The acknowledged reference method for maturity and fineness measurements on cotton is Image Analysis method (Thibodeaux *et al.*, 2000). Image Analysis has improved determinations of fiber biological fineness and maturity but it remains too slow and limited with respect to sample size. Huang and Xu (2002) reported that the Image analysis longitudinal measurements were

correlated well with the data obtained from other methods. Hequet and Wyatt (2004) reported that the Image analysis of the cross section of cotton fibers constitutes an excellent reference method for maturity and fineness measurements.

MATERIALS AND METHODS

Lint cotton samples of grade (Good) from five Egyptian cotton cultivars; Giza 45 and Giza 88 (extra long staple cultivars); Giza 85, Giza 86 and Giza 83 (long staple cultivars) were obtained from commercial cotton crop of 2003 season and used representing wide range of genetic finenesses. Micronaire reading, maturity ratio and fineness (linear density) in millitex were measured by Micromat tester (new F/M T instrument) according to (ASTM: D 3818-79, 1998). The biological fineness (perimeter and diameter) and wall thickness were calculated from equations as a function of low pressure (Pl) and high pressure (Ph) by using computer software according to Montalvo and Faught (1995). Perimeter, diameter and wall thickness were measured also from the Image analysis with computer system according to Huang and Xu (2002).

The samples were tested under controlled atmospheric conditions of 65 ± 2% relative humidity and 70 ± 2°F temperature at the Cotton Technology Research Institute, Giza, Egypt.

The obtained data were subjected to statistical analysis of variance according to Snedecor and Cochran (1976), L.S.D. test was used for comparing the different means. Simple correlation and regression analysis according to Draper and Smith (1966) were performed with a computerized SAS program.

RESULTS AND DISCUSSION

Micromat fiber fineness and maturity data is given in table (1). It shows substantial differences among cultivars for these properties. Micronaire reading ranges from 3.0 for Giza 45 (the finest cultivar) to 4.2 for Giza 83 (the coarsest cultivar) and maturity ratio ranges from 0.993 for Giza 86 to 1.043 for Giza 45. On the other hand, fiber fineness ranges from 113 millitex for Giza 45 to 164 millitex for Giza 83.

Table 1. Average values of Micromat fineness and maturity for some Egyptian cotton cultivars.

Cultivar	Micronair value	Maturity ratio	Fineness (Millitex)
Giza 45	3.0	1.043	113
Giza 88	3.8	0.995	143
Giza 85	4.0	1.017	146
Giza 86	4.1	0.993	154
Giza 83	4.2	0.997	164
LSD	0.081	0.221	2.44

Fiber fineness (perimeter and diameter) and maturity (wall thickness) data from Micromat Tester and Image Analysis are shown in table (2). The Micromat perimeter ranges from 42.72 microns for Giza 45 to 48.12 microns for Giza 83, while the Image Analysis perimeter ranges from 43.42 microns to 48.11 microns for the same cultivars. However, the Micromat diameter ranges from 13.60 microns for Giza 45 to 15.62 microns for Giza 83, but the Image Analysis perimeter ranges from 13.83 microns to 15.32 microns for the same cultivars. On the other hand, the Micromat wall thickness ranges from 2.07 microns for Giza 45 to 2.69 microns for Giza 83, while the Image Analysis wall thickness ranges from 2.26 microns for Giza 45 to 2.48 microns for Giza 85.

Table 2. Average values of Micromat data and Image Analysis data for some Egyptian cotton cultivars.

Cultivars	Micromat data			Image Analysis data		
	Perimeter (micron)	Diameter (micron)	Wall thickness (micron)	Perimeter (micron)	Diameter (micron)	Wall thickness (micron)
Giza 45	42.72	13.60	2.07	43.42	13.83	2.26
Giza 88	44.28	14.33	2.51	45.72	14.56	2.27
Giza 85	45.20	14.40	2.62	45.79	14.58	2.48
Giza 86	47.48	15.33	2.63	47.27	15.05	2.44
Giza 83	48.12	15.62	2.69	48.11	15.32	2.44
LSD	1.48	0.74	0.08	1.060	0.338	0.163

Simple correlation coefficients between Micromat Tester and Image Analysis perimeter, diameter and wall thickness average values are given in table (3). There are high significant correlations for all properties from Micromat Tester versus Image Analysis. The relation between the data from the two instruments is very good with r = 0.9273 for fiber perimeter, 0.9433 for fiber diameter and 0.8856 for fiber wall thickness.

Table 3. Simple correlation coefficients between Micromat and Image Analysis perimeter, diameter and wall thickness.

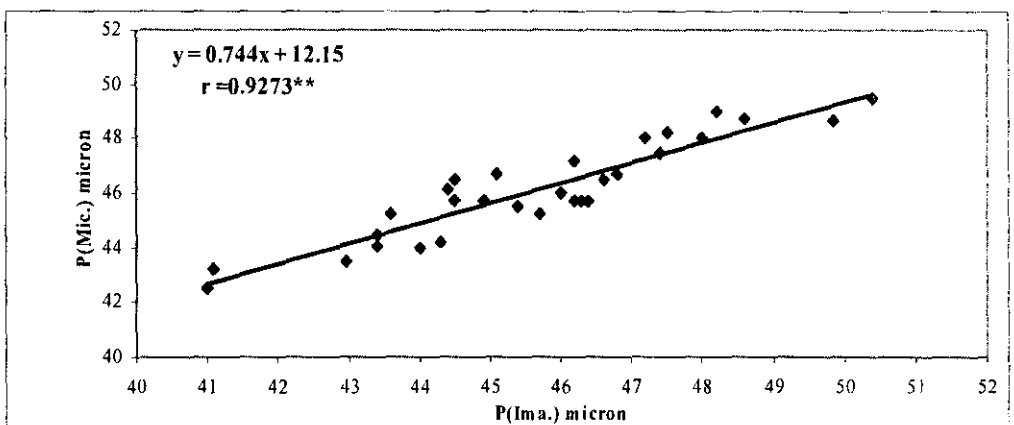
Properties	r
Fiber perimeter (P)	0.9273**
Fiber diameter (D)	0.9433**
Fiber wall thickness (T)	0.8856**

** High significance.

Figures (1,2 and 3) show the relationships between fiber perimeter, diameter and wall thickness measurements from Micromat Tester versus Image Analysis. It is clear that the Micromat data are well correlated with the data obtained from Image Analysis.

CONCLUSION

Traditionally, the cotton industry used gravimetric fiber fineness (linear density) as an indicator of the fiber fineness and maturity combined. The Micromat Tester is considered suitable for this objective, but is not used for acceptance testing due to low precision and accuracy. Reliable measurements of cotton fiber fineness as diameter or perimeter and fiber maturity as wall thickness could be determine rapidly by Micromat Tester. Success in this approach would provide an acceptable reference method, which is not currently available now. The breeder and the spinner will get direct, accurate and fast determinations of biological fineness in term of fiber perimeter, or diameter and maturity in term of wall thickness.



Fig(1)The relationship between fiber perimeter from Micromat (Pmic.) versus Image analysis(PIma.)

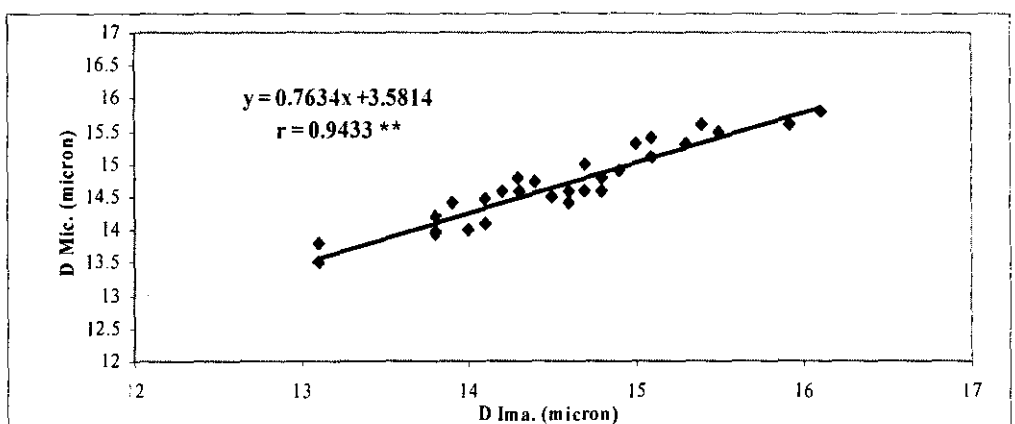


Fig. (2)The relationship between fiber Diameter (D Mic.) from Micromat versus Image analysis(D Ima.)

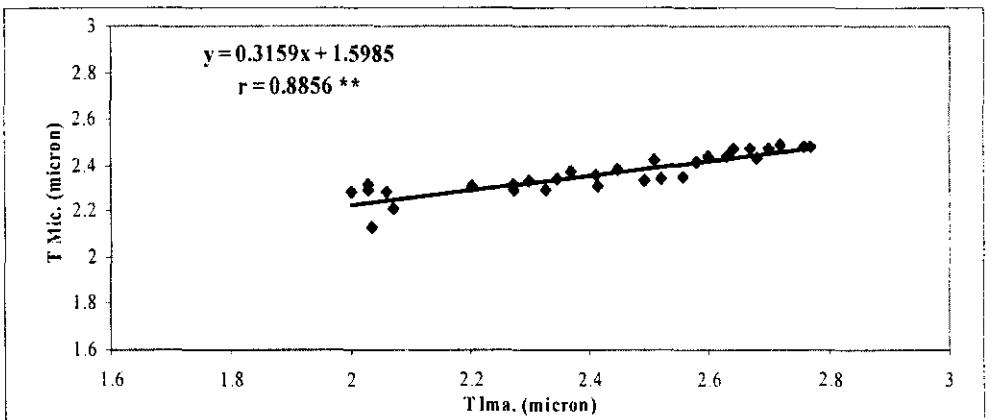


Fig.(3)The relationship between fiber wall thickeness from Micromat (T mic.) versus Image analysis(T Ima.)

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قياس محيط الشعرة وسمك الجدار لبعض أصناف القطن المصرى باستخدام جهاز الميكرومات

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تم إجراء هذا البحث بغرض الحصول على تقديرات مستقلة لكل من النعومة الذاتية (محيط وقطر الشعرة) والنضج (سمك الجدار) بإستخدام جهاز الميكرومات بجانب القراءات المعتاد الحصول عليها (ميكرونير ، نسبة النضج والنعومة بالوزن) . وقد إستخدم برنامج كمبيوتر بمعادلات خاصة إستخدم فيها قراءة الـ P_L (عند الكبس المنخفض للعينة) وقراءة الـ P_H (عند الكبس العالى للعينة) لتحويل هذه القراءات مباشرة إلى تقديرات النعومة الذاتية والنضج .

أستخدم فى هذه الدراسة خمسة أصناف من القطن المصرى إثنين منها تمثل الأقطان فائقة الطول (جيزة ٤٥ وجيزة ٨٨) والثلاثة الأخرى تمثل الأقطان الطويلة (جيزة ٨٥ ، جيزة ٨٦ ، جيزة ٨٣). تم إجراء الإختبارات بمعامل تكنولوجيا القطن – معهد بحوث القطن تحت ظروف قياسية من الحرارة ٧٠ °ف±٢ والرطوبة ٦٥±٢ % بجهازى الميكرومات والـــImage analysis .

أظهرت نتائج الدراسة أن الصنف جيزة ٤٥ أنعم الأصناف (أقلها محيط وقطر) بينما الصنف جيزة ٨٣ أخشنها (أكبرها محيط وقطر). والقياسات المتحصل عليها من جهاز الميكرومات على علاقة وثيقة (موجبة وعالية المعنوية) بالقياسات الفعلية بطريقة الـــ Image analysis فى قياسات النعومة الذاتية (محيط وقطر الشعرة) وكذلك (سمك الجدار) والتى تستغرق وقتا وجهدا كبيرين ويمكن الإعتماد عليها بدرجة معقولة من الثقة عند إختبار عينات مختلفة من القطن عند الإنتخاب فى برامج التربية لتحسين الأصناف أو عند تقدير جودة الألياف فى الأغراض الصناعية أو التجارية .