COTTON LENGTH AND STRENGTH MEASUREMENTS AS AFFECTED BY BUNDLE MASS

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Abstract

This study was carried out on three cotton groups included Egyptian ELS and LS cotton varieties besides some Upland cottons aiming to study the effect of specimen size on Fibrograph and HVI length measurements as well as on Stelometer and HVI strergth measurements. The effect of test specimen size on the precision degree (P.D %) of test results was also studied. The results showed that Fibrograph, HVI and Stelometer tests should be carried out within a specific range of test specimen size to get correct values with high degrees of accuracy. The relationship between test specimen size and each of length and strength measurements was also studied.

INTRODUCTION

The optical methods for measuring fiber length are well known to be affected by the amount of the specimen. Therefore, a speific range of that amount is recommended in Digital Fibrograph (600-900) and in HVI Fibrograph 910 (300-600) (instruction manuals of Fibrograph 530 and HVI Fibrograph 910). Within this range of amount the accuracy of testing is expected to be higher than testing beyond it .

Many investigators studied the effect of specimen mass on length and strength measurements in this conection. Lyons *et al.* (1973) found that mass measuring errors amounted to 20%. These errors were caused by the presence of different kinds and amounts of natural salts, which change the electrolytic response of water in the fibers. Taylor (1986) reported that measuring fiber length and strength in cotton encompasses sampling, fiber preparation and bundle clamping. The precision of the measurement is a function of these steps as well as the precision of measuring the force and mass of each bundle under test. He added that the test specimens under 400 optical amount led to inaccurate length measurements, whereas using the normal optical mass (450-900) led to more accurate length measurements and reduced errors.

Instrumental testing of cotton strength by using Stelometer and HVI requires a combined measurement of tensile force and speciemen mass. High Volume Instrument (HVI) use indirect methods (Light attenuation and air pressure) to estimate mass. Taylor and Godbey (1992) reported that HVI strength measuring errors were shown to be mainly due to errors in the indirect methods used to measure the mass of fibers tested for strength .

Dukett *et al.* (1994) recognized in HVI strength testing that light attenuation is not sufficient for an accurate mass determination, but that a correction involving micronaire assists in enhancing the predictability of the indirect measure. However, it would appear that light attenuation through an array of cotton fibers would be sensitive to a number of properties of the fiber comprising the array. Some of these are fiber cross-sectional area and geometry, projected fiber shadowing dimensions, convolutions, and crimp. Even distribution frequencies of these factors may be important because they vary with position along the beard from clamping surface to specimen tip .

Palmer *et al* (1994) found a stronger correlation between yarn strength and fiber strength measured by the Stelometer than by HVI classing. They added that High Volume Instrument testing still does not provide as much useful information to plant breeding purposes, as individual instruments .

MATERIALS AND METHODS

The present study was carried out at Cotton Research Institute during 1994 season. Materials included three groups; (a) Egyptian Extra-long Staple (ELS) cotton varieties, Giza 45, Giza 70 and Giza 77, (b) Egyptian Long-staple varieties (LS) Giza 75, Giza 80 and Giza 81, and (c) the upland Medium Staple (MS) cotton varieties McNair 220, MCNair 308 and McNair 235. The mentioned cotton varieties were shosen to provide a wide range of fiber length and strength measurements.

Aiming to study the effect of the optical mass on fiber length measurements

(50 % and 2.5% Span length), a 1 Kilogram representative sample from each cotton variety was well blended and used for preparing the test specimens. 36 test specimens (combs) were prepared by using the Fibrosampler to be tested by Digitial Fibrograph (Spinlab model 530), of which, 12 test specimens were within the recomended range of amount (from 600 to 900), another 12 test specimens were below the recomeded amount range (below 600), and the last 12 test specimens were over the reomened amount range (over 900).

The Spinlab 900B, HVI system (Fibrograph 910 unit) was used to measure fiber length 50% and 2.5 % span lengths as well as fiber strength. Using test specimens of different optical mass, i.e., within, below and over the recommended range of amount by programing the insturment to change the mass range to be from (200 to 800) instead of the recomended range of amunt which is from (300 to 600) to be able to do the testing, since the instrument rejects any test specimen over or below the specified range.

To study the effect of bundle mass (weight) on fiber strength, the Stelometer 154 instrument was used to measure flat bundle strength. The testing procedure used was to prepare normal, light and heavy bundles, considering the samples that recorded breaking load (2-6 kg) to be within the recomended mass range , those recorded less 2 kg breaking load were regarded as below the recomended mass range, and those recorded over 6 kg were considered as over the recomended mass range. 36 test specimens of each variety were used in testing .

All tests were carried out under controlled temperature of $20^{o}C \pm 2$ and relative humidity of 65 % ± 5. The Fibrograph testing was done according to ASTM - D-1447-67, the Stelometer testing was done at 1/8 inch gauge length according to ASTM-D-1445-67 and the High Volum Instrument (HVI) testing was accoplished according to ASTM : D-4605-86.

The data obtained from each cotton group were averaged to get representatvie values for length and strength measuremens and precision degree to be used to compare the effect of test specimen mass on these variables. Simple correlation coefficients between test specimen mass with fiber length and strength measurements were calculated. The precision degree (P.D %) was computed for the different instruments, and for the different cotton groups under the three ranges of test specimen mass according to the followin formula (ASTM, 1954: 605): $E^2\% = (t^2 \times v^2) / n$, where; E^2 % = the relative error %, v = coefficient of variation, t = tabulated t, and n= number of tests. P.D %= 100-E^2 %.

RESULTS AND DISCUSSION

1- Effect of specimen optical mass on fiber length measurements

The results in Table (1) and Figures (1 and 2) show the mean values of 2.5% and 50% span length measured by Fibrograph 530 and HVI Fibrograph 910 as well as the precision degree (P.D %) for each cotton group (ELS, LS and Upland cottons) under three levels of specimen optical mass in the two instruments. The results show that fiber length measurements; 2.5% S.L and 50% S.L. measured by Fibrograph 530 and HVI 910 were influenced by specimen optical mass. In the two instruments the below recomended optical mass generally showed 50% SL and 2.5% SL measurements slightly shorter, whereas the over recomended optical mass showed length measurements longer than those obtained from testing within the recomended specimen optical mass .

The precision degree % (P.D %) of testing showed a definite trend to be lower outside the recomended range of specimen optical amount in both Fibrograph 530 and HVI Fibrograph 910, irrespective of the cotton group. Moreover, the P.D % of 2.5% S.L measurements was higher than those for the 50% S.L measurements irrespective of the cotton group and the instrument used. The HVI Fibrograph 910 showed higher values of P.D % than those obtained from the Fibrograph 530, but the results do not show this trend for 2.5% S.L. however, it showed it for 50% S.L. This could be attributed to the constant mechanical brushing rate and the use of computer in case of Fibrograph 910 that led to increasing the precision degree % of testing. In this direction, Taylor (1986) found that different levels of brushing for crimp removal produced an average 11.5 % difference in indicated sample mass when compared to the actual mass for these specimens .

As shown in Table 2, the simple correlation coefficients between length measurements and specimen optical mass were significant when calculated from the whole data below or over the recomended range of specimen optical amount, whereas, this relationship was not significant when calculated from the data obtained from testing for the recomended range of optical mass on the two instruments for each of the three studied cotton groups. The absence of the relationship between length measurements and test specimen optical mass within the recomended range indicated that higher reproducible length test results could be obtained in the recomended range. In conclusion, preparing test specimens below or over the recomended optical mass could affect the length measurement and the accuracy of testing. Taylor (1986) and Ducket *et al.* (1994) are in line with these conclusions .

Table 1. 2.5 % and 50% span length measurements and P.D. % under different specimen optical mass using Fibrograph 530 and 910.

Group		Fibrograph 530						Fibrograph 910					
		2.5 % S.L. (mm)			50 % S.L. (mm)			2.5 % S.L. (mm)			50 % S.L. (mm)		
		Below 600	Rec. 600-900	Over 900	Below 600	Rec. 600-900	Over 900	Below 300	Rec. 300-600	Over 600	Below 300	Rec. 300-600	Over 600
Extra-long	(mm)	32.8	33.4	34.1	15.5	16.0	17.9	33.4	34.2	34.8	15.5	16.1	17.9
Cottons (ELS)	P.D%	92.2	96.5	90.6	87.1	96.9	81.9	91.8	98.4	88.5	91.2	96.1	86.9
Long cottons	(mm)	29.1	30.1	30.4	14.8	15.1	16.5	29.3	30.2	30.9	14.1	14.8	15.9
(LS)	P.D%	91.4	96.4	90.0	90.3	95.5	82.4	88.6	98.3	87.5	90.6	95.3	83.9
Upland cottons	(mm)	26.4	27.4	28.1	12.4	13.4	15.2	28.8	29.2	30.4	12.6	13.5	14.8
(SL)	P.D%	90.1	96.6	89.9	82.3	92.9	79.3	88.4	98.4	87.5	93.5	96.9	91.2
Mass average	P.D%	91.2	96.5	90.1	86.6	94.5	81.2	89.6	98.4	87.8	93.4	96.1	87.3
Overall Mass			92.5			87.3			91.9			92.2	

Table 2. Simple correlation coefficients between specimen optical mass and 2.5% or 50% span length (mm) values obtained by Filograph 530 and 910.

Group	Fibrograph 530								Fibrograph 910							
	2.5 % Span length				50 % Span length				2.5 % span length				50 % span length			
	600	Rec. 600-900	900	Overall	600	Rec. 600-900	900	Overall	300	Rec. 300-600	600	Overall	300	Rec. 300-600	600	Overall
Extra-long Cottons ELS	** 0.621	0.231	** 0.422	** 0.710	* 0.407	0.329	** 0.585	** 0.720	** 0.522	0.333	** 0.554	** 0.752	** 0.458	0.287	** 0.778	** 0.751
Long cottons LS	** 0.705*	0.002	** 0.753	** 0.776	** 0.551	0.372	** 0.748	** 0.575	* 0.403	0.234	** 0.356	** 0.575	** 0.583	0.148	** 0.553	** 0.523
Upland cottons SL		0.104	** 0.448	** 0.581	* 0.399	0.205	** 0.513	** 0.581	** 0.552	0.299	** 0.511	** 0.542	** 0.667	0.205	* 0.405	* 0.398

r 0.05 = 0.398 r 0.01 = 0.418, m = 36

2- Effect of specimen mass on fiber strength measurements :

a) Effect of stelometer bundle weight on flat bundle strength :

As shown in Table (3) and Figure (3), the results indicated that the light bundles (breaking load less than 2kg) showed higher values of fiber strength, whereas the heavy bundles (breaking load more than 6 kg) showed lower fiber strength values in the three studied cotton groups, as compared with fiber strength values obtained when testing within the recommended bundle size range (breaking load 2-6 kg). Moreover, testing precision degree % decreased when using light test specimens, and decreased sharpley when using heavy test specimens, as compared with the precision degree obtained from testing within the recomended test specimens range .

b) Effect of optical mass in HVI 910 Fibrograph on fiber strength measurements :

The results in Tables (3 and 4) and Figure (3) showed that fiber strength values of the three cotton groups followed a reverse of what shown by stelometer data. It increased as the test specimen optical mass increased. On the other hand, the precision degree (P.D %) decreased when testing outside the recommended optical amount, irrespective of the cotton group. Concerning the relationship between fiber strength values, and each of Stelometer bundle weight and HVI Fibrograph 910 test specimen optical mass, the simple correlation coefficients in Table, (4) were significant when calculated from the data obtained from the bleow and over recommended test specimen mass, whereas, the simple correlation coefficients calculated from the recomended range data were not significant whether in the stelometer testing or the HVI 910 testing. The significance of the relationship between test specimen mass and strength values assured the effect of test specimen mass on fiber strength whereas the absence of this relationship within the recomended range of test specimen mass cleared that within this range the test specimen size did not affect the strength values. The results also showed that the precision degree of fiber strength testing by using the stelometer was generally lower than those for HVI fiber strength testing, particularly when the tests were outside the recommended range of test specimen size. On the contary, Taylor and Godbey (1993) found that the accuracy of HVI strength measurements was significantly lower when compared to stelomenter vlaues. Increased HVI errors were likely due to an uncontrolled level of fiber crimp in some cottons and the indirect methods used to measure linear density.

They added that there is a need to evaluate fiber sampling for bundle strength.

In Table (3), the high degree of precision of the HVI strength values could be attributed to the automatic sampler with HVI tester which produces test specimens more closely representative to cotton source than specimens prepared manually for strength test by stelometer method. Taylor and Godbey (1992) mentioned same interpretation.

Table 3. Fiber strength values and P.D. % under different specimen size using Stelometer 154 and Fibrograph 910.

Group		Stelometer 154, breaking load			Fibrograph 910, Optical mass		
		Below 2 kg	Rec. (2-6) kg	Over 6 kg	Below 300	Rec. 300-600	Over 600
Extra-long	g/tex	37.9	34.4	33.1	33.1	33.7	34.5
Cottons (ELS)	P.D.%	87.1	92.5	52.8	98.2	99.4	97.9
Long cottons	g/tex	33.8	29.5	28.3	28.5	29.4	30.4
(LS)	P.D.%	85.5	88.0	51.3	98.3	29.5	97.7
Upland cottons	g/tex	24.4	21.5	20.2	21.5	99.5	22.7
(SL)	P.D.%	81.1	87.9	63.5	98.4	21.5	97.7
Overall Mass		84.9	89.5	55.9	98.3	99.5	97.7

In concolusion, test specimen weight in stelometer testing and optical mass of test specimen in HVI Fibrograph 910 proved to affect fiber strength values and the accuracy of this testing. Therefore, the testing should be within the recommended range of test specimen size to avoid unreliable values of strength because of the lower degree of precision. In this direction, Taylor et al (1986) and James and Richard (1993) stated that fiber specimens prepared by the automatic sampler for HVI tests are more closely representative of cotton source than specimens prepared for strength tests .

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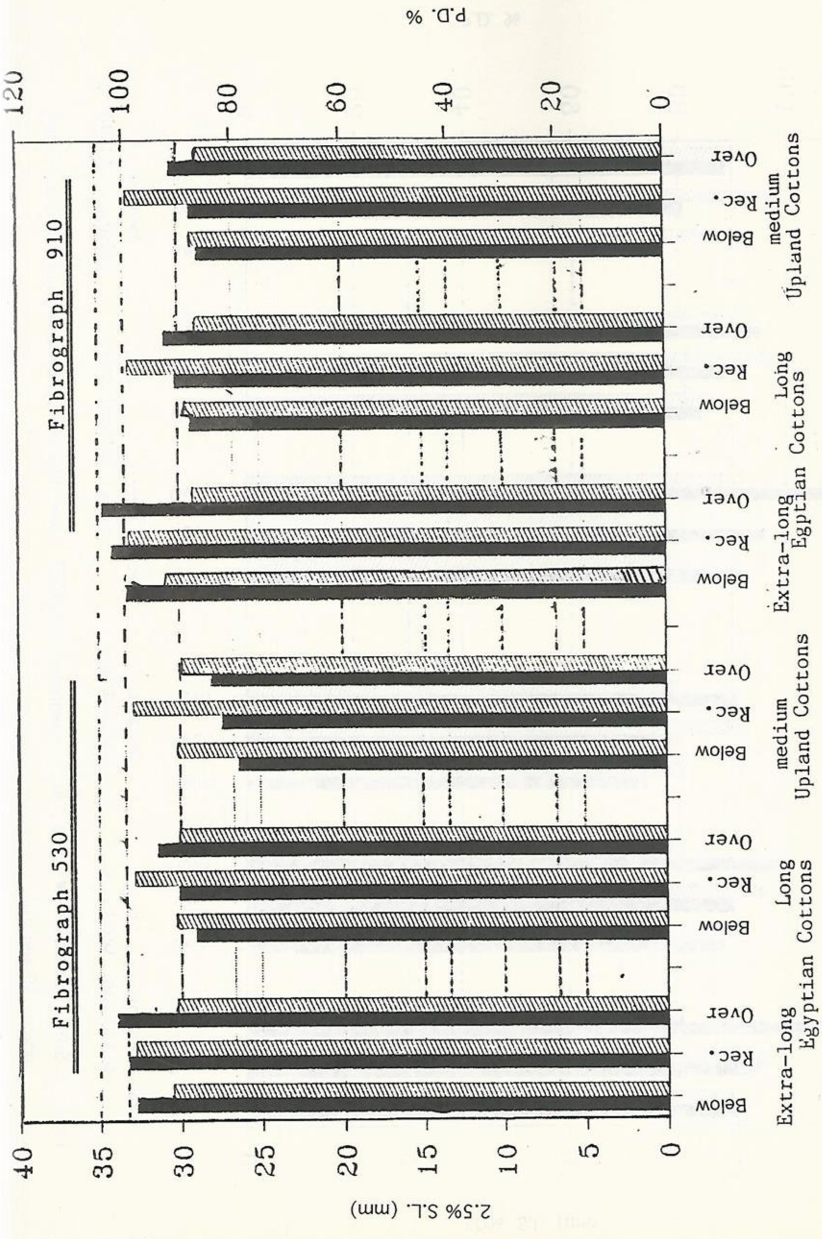

Figure 1. 50% span length (■) and precision degree (P.D %) (▨) under different specimen optical mass using Fibrograph 530 and 910.

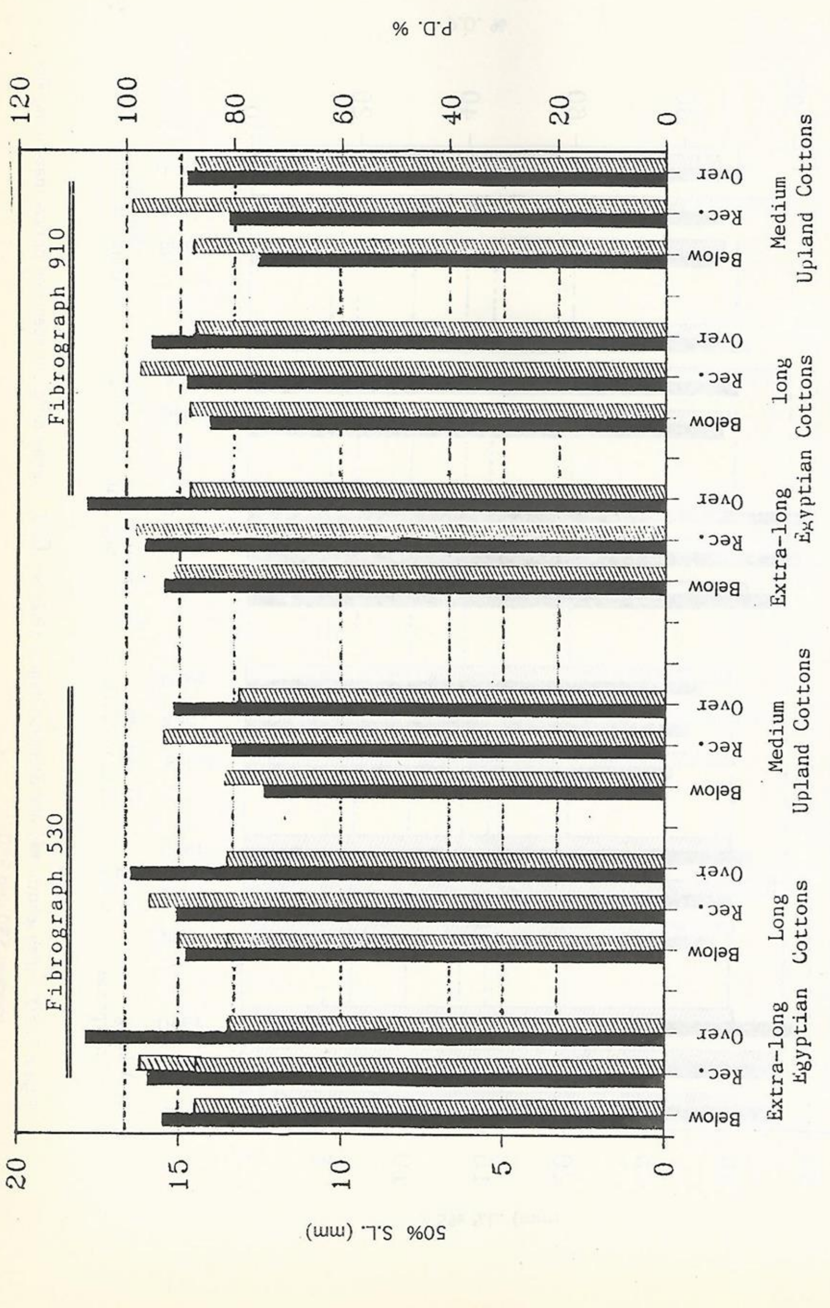

Figure 2. 50% span length (■) and precision degree (P.D %) ▨ under different specimen optical mass using Fibrograph 530 and 910.

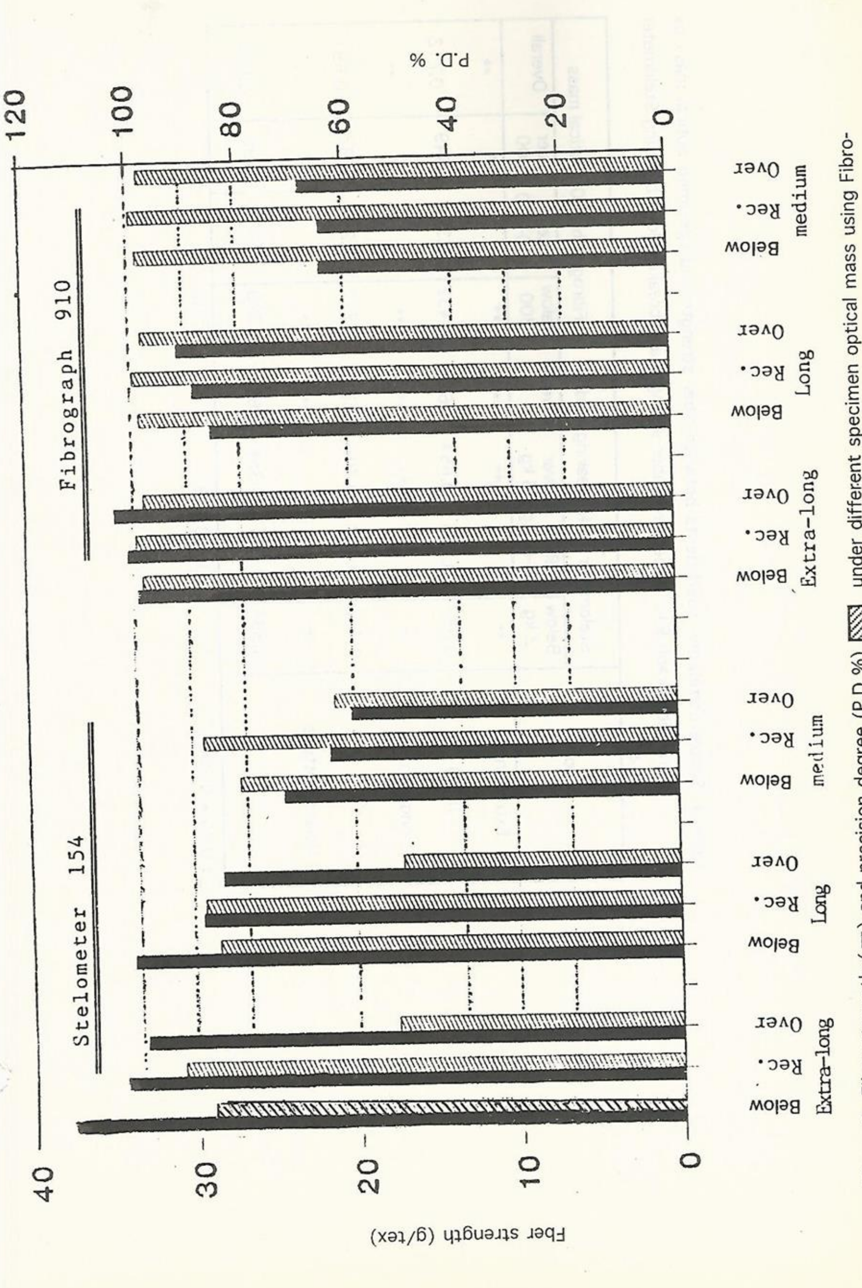

Figure 3. Fiber strength (■) and precision degree (P.D %) ▨ under different specimen optical mass using Fibrograph 530 and 910.

Table 4. Simple correlation coefficients between fiber strength and specimen optical mass by using Fibrograph 910 or between fiber strength and breaking load by using Stelometer 154.

Group	Stelometer 154, breaking load				Fibrograph 910, Optical mass			
	Below 2 kg	Rec. (2-6) kg	Over 6 kg	Overall	Below 300	Rec. 300-600	Over 600	Overall
Extra-long	**		**	**	**		**	**
(ELS)	0.857	0.235	-0.654	0.687	0.432	0.354	0.549	0.712
Long cottons	**		**	**	**		**	**
(LS)	0.785	0.362	-0.402	7.21	0.577	0.294	0.632	0.691
Upland cottons	**			**	*		**	**
(SL)	0.884	0.294	-0.356	0.631	0.399	0.285	0.495	0.605

r 0.05 = 0.398 r 0.01 = 0.418 n = 36

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تأثير حجم عينة الاختبار علي قياسات طول ومتانة تيلة القطن

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أجرى هذا البحث بهدف دراسة تأثير كمية الشعيرات من القطن علي قياسات طول التيلة عند نسبتي توزيع ٢,٥٪ ، ٥٠٪ باستخدام جهازي الفيبروجراف ٥٣٠ والفيبروجراف ٩١٠ H.V.I. هذا بالاضافة الي دراسة تأثير كمية الشعيرات المختبرة من القطن علي متانة التيلة عند مسافة ١/٨ بوصة باستخدام جهاز الاستيلوميتر التقليدي والجهاز الحديث H.V.I.

استخدم في الدراسة عينات ممثلة لمجموعة الاقطان المصرية فائقة الطول أصناف جيزة ٤٥ ، جيزة ٧٠ ، جيزة ٧٧ لمجموعة الاقطان المصرية الطويلة أصناف جيزة ٧٥ ، جيزة ٨٠ ، وجيزة ٨١ بالاضافة الي لمجموعة الاقطان الطويلة وسط – الاقطان الا بلند الامريكية – ماكنير ٢٢٠، ماكنير ٢٣٥، ماكنير ٣٠٨ . وتم الحصول علي قياسات لطول التيلة ومتانتها لثلاث مستويات من حجم عينة الاختبار ، الحجم الموصي به لكل جهاز بالاضافة الي حجمين اقل واعلي من الحجم الموصي به.

ويمكن تلخيص النتائج فيما يلي :

١- اتضح زيادة الطول عند نسبتي توزيع ٢,٥ ٪ المقاسة بجهازي فيبروجراف ٥٣٠ ، وفيبروجراف ٩١٠ H.V.I. بزيادة حجم عينة الاختبار من المستوي الادني الي المستوي الاعلي من حجم عينة الاختبار الموصي به ، وقد كان ذلك واضحا في مجموعات القطن الثلاث تحت الدراسة.

٢- انخفضت درجة الدقة لقياس طول التيلة عند نسبتي توزيع ٢,٥ ٪ ، ٥٠ ٪ لكل من مستوي حجم العينة الاقل والاعلي بالمقارنة بالمستوي الموصي به لحجم عينة الاختبار . وقد لوحظ زيادة درجة الدقة لقياس طول التيلة عند نسبة توزيع ٢,٥ ٪ عن نسبة توزيع ٥٠ ٪ وذلك بصفة عامة لكل مجموعة قطن تحت الدراسة وفي كلا الجهازين .

٣- زادت قياسات متانة الخصلة المقدرة بجهاز ٩١٠ H.V.I بزيادة حجم عينة الاختبار وكان ذلك واضحا في مجموعات القطن الثلاث المختبرة بينما نقصت قياسات متانة الخصلة المقدرة بجهاز الاستيلوميتر بزيادة حجم عينة الاختبار " وزن الخصلة".

٤- اعطي حجم العينة الاقلوالاعلي من الموصي به نقص في درجة الدقة في جهاز الاستيلوميتر ١٥٤ التقليدي والجهاز الحديث H.V.Iإلا أن هذا النقص كان أوضح و أشد في حالة الاستيلوميتر عن H.V.I.وبصفة عامة في مجموعات القطن الثلاث كانت درجة الدقة فى H.V.I. أعلى قليلا منهما باستخدام جهاز الاستيلوميتر وذلك عند استخدام الحجم الامثل لكل جهاز.