

Accuracy of Fibrotest for Cotton Fiber Length and Strength Measurements

Ibrahim Ahmed Ebaido

Cotton Grading Department, Cotton Research Institute
Agricultural Research Center (ARC), Egypt

Mona El-Sayed Shalaby and Yasser ShokryAbd-El-Rahman

Cotton Grading Department, Cotton Research Institute
Agricultural Research Center (ARC), Egypt

ABSTRACT

For investigation of the accuracy of FIBROTEST used two categories of standard calibration cotton, long/strong and short/weak. The present study was carried out at Cotton Research Institute (CRI), Agricultural Research Center (ARC), Giza, Egypt. Before carrying out the tests, the cotton samples were incubated in the BINDER equipment for two days to reach the standard conditions for the tests. The measurements that were analyzed are: length measurements properties, i.e., upper half mean, upper half mean relative to HVI, 50% span length, 2.5% span length, mean length, uniformity index, uniformity index relative to HVI, short fiber content and short fiber index, and strength properties, i.e., absolute strength, strength relative to HVI, elongation, bundleweight, linear density, force, work and time at break. Results indicated that fiber length and strength measurements showed few differences for long / strong and short / weak cotton. The values of these measurements were distributed symmetrically with low skewness and kurtosis. The FIBROTEST gave values for UHM, UI and strength very close to their actual values. It can be admitted that this device is accurate in measuring, but to ensure this is achieved, especially for fiber strength, it is necessary to test a large number of subsamples. Since linear density is the actual effect of fiber strength, so to avoid this, emphasis is placed on linear density to achieve a more accurate measure of strength. The most suitable linear density for the long / strong cotton was 1723 and for the short / weak was 1274. To obtain a specific and repeated amount of linear density to achieve an accurate measurement of strength, the Fibro-sampler has to be considered in any development or modernization of the FIBROTEST device.

Keywords: Accuracy, cotton fiber length and strength, linear density, FIBROTEST, Fibro-sampler

INTRODUCTION

Developing cottons with improved fiber quality is a major concern with target of the breeding programs around the cotton farming world. The priority of these programs is most often given to the improvement of fiber length, fineness and strength. It is important to help cotton breeder to develop varieties for enhanced fiber end use qualities. Therefore, Hsieh (1999) stated that ranked importance of these fiber properties differs with the nature of yarn spinning method.

Cotton fibers are not homogeneous and their physical properties differ from one fiber to another as the fibers have a great diversity within the sample. The task force on commercial standardization of instrument testing of cotton (CSITC) promotes the use of objective and reliable instrument testing instead of manual classing, through the cotton value chain and help to establish international standardization of cotton classification based on the universal calibration cotton standards in order to promote efficiency in cotton production and marketing (Beltwide Cotton Conference, 2007).

Length is one of the most important properties of cotton fibers; longer fibers are generally stronger than shorter ones. Yarn quality parameters such as strength, elongation, evenness and hairiness are influenced with the length of cotton fibers. Therefore it is very important for fiber producers and spinners to be able to measure the length distribution of cotton fibers (Braden, 2005, Thibodeaux *et al.*, 2008 and Azzouzet *et al.*, 2008). Short fiber content of cotton is one of major concerns in the textile industry as the presence of excessive amounts of short fibers can give rise to low production efficiencies and poor quality of the end product (Ebaido and Rokya, 2011). Fiber strength is generally considered to be one of the most rigorous properties of importance amongst fiber properties. Admittedly, that the importance of fiber elongation and strength and their contribution to yarn quality (Frydrysh, 1992, Krifa and Ethridge, 2006 and Ute and Kadoglu 2014). The cotton fiber elongation is an important cotton fiber property that directly affects yarn elongation and work-to-break values (Yang and Gordon, 2016 and Hassan and Ibrahim, 2018).

Thus, having improved elongation tends to positively influence the overall fiber quality (Ruvini *et al.* (2020). Ghosh and Mal (2019) revealed that fiber elongation is a vital tensile in terms of fiber processing. The weaker fibers that possess high elongation tend to perform better in processing. Thus, in terms of processing, fiber elongation seems to be in equal importance with fiber strength. The same specimen will show a lower strength when the time to break is low, or higher when the time to break is high (Ghosh and Mal, 2019). At the premises of Textile Testing Technology (TexTechnoCompany), the Fiber Classifying System (FCS) designed to measure all fiber properties which determine the quality and the spinnability of both, cotton and man-made fibers. This system can be calibrated with calibration cotton to yield High Volume Instrument (HVI). The Fiber Classifying System (FCS) consists of four modules, i.e., FIBROTEST measures length and strength traits, Wira measures fineness and maturity and Optotest measures color and trash traits (Ebaido *et al.* 2017).

The FIBROTEST device is one of the fiber testing instruments worldwide which have received the ITMF recognition (2012), indicating that the instrument is well-suited for spinning mills and research institutes. FIBROTEST is a testing device for the absolute determination of the length distribution, as well as the fiber bundle strength and elongation of cotton fibers. The advantages of the FIBROTEST are that this testing device is able to perform two different testing modes: direct mode and HVImode (Kugler *et al.*, 2013). The two measurements (length & strength) of FIBROTEST are executed in succession on the same sample. As final step of the fiber bundle test the sample mass is automatically determined. This enables to calculate the exact and absolute value of the strength (Kugler, 2018). In this case the cotton specimen is measured in relation to long/strong and short / weak standard calibration cotton. If you can't trust your measurement system, then you can't trust the data that the instrument produces. So

what types of measurement system errors may be taking place? Here's where precision and accuracy come into play. The objective of this study was using cotton fiber measurements of FIBROTEST to give an overview for its precision and accuracy.

MATERIALS AND METHODS

The present study was carried out at Egyptian & International Cotton Classification Center (EICCC), Cotton Research Institute (CRI), Agricultural Research Center (ARC), Giza, Egypt. The materials used are two parcels of standard calibration cotton samples, one long / strong and the other short / weak (Table 1). These universal samples were brought from the company Textechno, the manufacturer of the FIBROTEST instrument (Image 1). These samples were incubated in BINDER equipment to ensure the standard conditions for cotton tests, which are 65 ± 2 % RH and 21 ± 1 °C.

Table 1. The actual mean values of length & strength of standard calibration cottons

Sample	UHM (mm)	UI (%)	Rel-STR (g/tex)
Long / strong	35.15	85.4	42.4
Short / weak	28.25	82.5	25.8

The modular Fiber Classifying System (FCS) determines the quality of the incoming raw cotton fibers and cotton slivers in order to optimize the spinning process. Fiber Length and Strength Tester (FIBROTEST) instrument is the main module of the FCS and incorporates both fiber length and bundle strength measurements on same sample. The tester consists of the actual measuring instrument and separate mechanical pneumatic equipment for sample preparation (Fibro-sampler, Image 2).

The glossary of measurement names is listed as follow;

USDA- HVI Mode	
UHM (mm)	Absolute Upper Half Mean
Rel-UHM (mm)	Upper Half Mean relative to HVI
ML (mm)	Mean Length
UI (%)	Uniformity Index
Rel-UI (%)	Uniformity Index relative to HVI
SFC (%)	Short Fiber content
SFI (%)	Short Fiber Index
International Calibration Cotton (ICC) Mode	
2.5% SL (mm)	2.5% SL span length
50 % SL (mm)	50 % SL span length
UR (%)	Uniformity ratio
Abs-STR (g/tex)	Absolute strength
Rel-STR (g/tex)	Strength relative to HVI
E (%)	Elongation
Force	Force to break
Time	Time to break
Work	Work to break
BW	Bundle Weight
LD	Linear Density

In the Fibro-sampler the preparation of the sample (comb) is made by means of a flat carding sampler. In order to guaranty, that nearly always the same sample amount is collected by the comb (in case of FIBROTEST: magazine called). A pneumatic system is used to press the fiber sample against the perforated top plate of the sample chamber with a defined pressure. After the preparation of the sample the prepared sample comb is put into the FIBROTEST device, using a brush, loose fibers are removed and at the same time the fibers are aligned to be parallel by operator. Practically the influence of the operator on to the test results depends only on two steps of the sample preparation as follow;

- (1) From the fiber collection on the flat carding sampler and,
- (2) From the manual brushing of the sample before testing.

Fiber length is measured by passing the beard of parallel fibers through an optical sensing point. The beard is formed when fibers from a sample of cotton are automatically grasped by a clamp, then combed and brushed into parallel orientation. After completing these measurements the sample mass is automatically determined, which enables to calculate the exact and absolute values of fiber strength and elongation. The operation of the FIBROTEST does not require any calibration for absolute mode, while need calibration with a standard cotton sample for HVI mode.

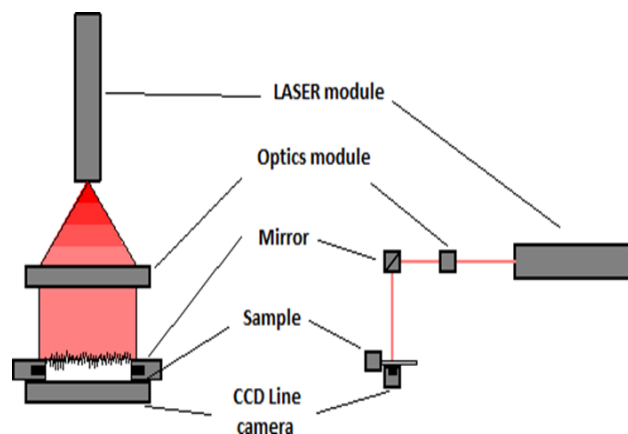


Image 1. The illustration of the FIBROTEST instrument



Image 2. The scheme of the Fibro-sampler

The procedure for this study was for more than one operator randomly to perform the tests on the FIBROTEST device on separate days during a whole year (2020). The tests were conducted on a number of 400 subsamples for the long/ strong and likewise for short/ weak standard calibration cotton.

Using Minitab™ 16 software (Minitab, Inc., State College, PA), the collected data were subjected to the proper analysis of descriptive statistics, simple correlation and graphical summaries.

RESULTS AND DISCUSSION

Precision refers to how close measurements are to each other, while accuracy refers to how close measurements are to the "true" value. In other words, accuracy describes the difference between the measurement and the part's actual value; while precision describes the variation has seen when measuring the same part repeatedly with the same device. Precision can be broken down further into two components:

Repeatability: The variation observed when the same operator measures the same part repeatedly with the same device.

Reproducibility: The variation observed when different operators measure the same part using the same device.

PRECISION OF FIBROTEST MEASUREMENTS

As mentioned, the procedures followed in this research are that for more than one operator randomly on separate days to perform the tests of long / strong and short / weak standard cottons on the FIBROTEST during a whole year. Therefore, the precision of the device was addressed in terms of reproducibility.

FIBROTEST fiber length measurements for long / strong and short / weak standard cotton

Descriptive statistics for Fiber length measurements for long / strong standard cotton, i.e., UHM, Rel-UHM, ML, UI, Rel-UI, SFC, SFI, 2.5% SL, 50 % SL and UR are summarized in Table 2. The lower values of CV % show the few differences in fiber length measurements, except for SFC and SFI. Mean values of Rel-UHM is higher than each of UHM and 2.5% SL; Whereas, UI % and Rel-UI % values are nearly the same. It's clear that mean and median values are approximately the same indicating symmetric distributions of these measurements. Therefore, we find that the skewness values are close to zero, whether positive or negative. The skewness and kurtosis coefficients measure how different a given distribution is from a normal distribution. Note, Q1 indicates that exactly 25% of values are less than the first quartile (Q1); also Q3 indicates that exactly 75 % of values are less than the third quartile (Q3). This makes it clear where the mean values are located in all the trait data.

Table2. Descriptive statistics for FIBROTEST length measurements of long / strong standard cotton

Sample	Statistics	UHM	Rel-UHM	ML	UI %	Rel-UI %	SFI	SFC	2.5 % SL	50 % SL	UR %
Long / strong standard cotton N = 400	Mean	35.36	36.59	30.89	87.4	87.3	4.46	7.44	35.74	16.03	44.8
	Median	35.40	36.7	30.90	87.4	87.3	4.40	7.52	35.8	16.1	44.9
	SD	0.550	0.613	0.971	1.76	1.43	1.92	2.18	0.595	0.911	2.21
	CV %	1.56	1.67	3.14	2.04	1.64	10.30	26.57	1.65	5.68	4.93
	Q 1	35.00	36.2	30.2	85.7	86	2.64	7.63	35.4	15.2	43.2
	Q 3	35.7	37	31.6	87.7	88.4	6.19	8.05	36.1	16.8	46.5
	Skewness	-0.47	-0.45	-0.15	0.01	0.02	0.36	0.01	-0.38	0.02	-0.02

Descriptive statistics for Fiber length measurements for short / weak standard cotton are shown in Table 3. It is clear that the descriptive statistics for short / weak parameters do not differ much from the long / strong standard cotton. In which Rel-UHM is higher than UHM and 2.5 % SL; and also the symmetry of data distribution, with a slight difference, where the skewness is somewhat more.

Table 3. Descriptive statistics for FIBROTEST length measurements of short / weak standard cotton

Sample	Statistics	UHM	Rel-UHM	ML	UI %	Rel-UI %	SFI	SFC	2.5% SL	50% SL	UR %
Short / weak standard cotton N = 400	Mean	29.17	29.64	24.33	83.4	84.0	5.75	8.21	29.07	13.41	46.1
	Median	29.20	29.70	24.43	83.4	84.0	5.72	8.18	29.10	13.40	45.9
	SD	0.533	0.592	0.729	1.27	1.04	1.23	1.14	0.567	0.623	1.65
	CV %	1.82	1.99	3.00	1.53	1.24	9.58	6.01	1.96	4.69	3.58
	Q 1	29.00	29.40	24.13	82.8	83.5	5.26	8.42	28.90	13.20	45
	Q 3	29.50	30.00	24.82	84.3	84.8	5.99	8.89	29.40	13.90	47.5
	Skewness	-0.82	-0.81	-1.28	-0.83	-0.84	1.47	0.81	-0.78	-0.97	-0.31

FIBROTEST fiber strength measurements of long / strong and short / weak standard cotton

The tensile strength measurements of long / strong standard cotton, i.e., absolute strength, strength relative to HVI and elongation; and the parameters that affect strength, i.e., force to break, bundle weight, linear density, work to break and time at break are monitored in Table 4. First, refers to fiber strength = Force to break / linear density, and E % = (area / work to break) * 100. The absolute strength (Abs-STR) exhibits lower values than the strength relative to HVI

(Rel-STR) to large extent. It is worthy to mention that, values of Abs-STR are compatible and equivalent with single yarn strength values. Abs-STR, Rel-STR and E % have slight variations, since SD and CV % values are small; Whereas, Force, BW, LD, Work and Time to break are subject to wide variations. Fiber strength and elongation measures and Force, BW and LD show similar values, to large degree of mean and median, this indicating the symmetric distribution of their data with small skewness. On the other hand, mean and median values are not close for Work and Time, so their distribution skewed more.

Table 4. Descriptive statistics for FIBROTEST strength measurements of long / strong standard cotton

Sample	Statistics	Abs-STR	Rel-STR	E %	Force	BW	LD	Work	Time
Long / strong standard cotton N = 400	Mean	24.68	44.28	10.9	373	4.87	1535	1092	0.372
	Median	24.70	44.35	10.6	379	4.95	1560	1007	0.300
	SD	1.67	2.38	0.713	71.7	0.788	246.2	289.8	0.234
	CV %	6.77	5.37	7.32	19.2	16.9	16.1	26.51	53.2
	Q 1	23.70	42.90	10.0	316.3	4.24	1332	879	0.350
	Q 3	25.81	45.90	11.4	437.9	5.52	1736	1339	0.390
	Skewness	-0.25	-0.24	0.54	-0.31	-0.13	-0.15	0.86	1.35

Table 5 exhibits the descriptive statistics for Abs-STR, Rel-STR, E%, Force BW, LD, Work and Time of short / weak standard cotton. It is obvious that the mean values of all measurements are lower than that of long / strong cotton, except for BW and LD, approximately the same. Likewise, as of long / strong standard cotton, Force, BW, LD, Work and Time manifested in their data CV % values more than the strength and elongation measures. The mean and median values are fairly close to each other for all FIBROTEST measurements. The data of the measurements distribute symmetrically with slight negative skewness. It is worth noting that the values of BW and LD are somewhat similar for long / strong and short / weak standard cotton; whereas the values of Force, Work, and Time for long / strong are higher than the short / weak ones. This proves that the stronger fibers require more force and drains more Work and Time.

Table 5. Descriptive statistics for FIBROTEST strength measurements of short / weak standard cotton

Sample	Statistics	Abs-STR	Rel-STR	E %	Force	BW	LD	Work	Time
Short / weak standard cotton N = 400	Mean	13.76	28.72	8.94	211.3	4.93	1556	669.6	0.256
	Median	13.85	28.85	9.10	216.6	5.00	1580	670.3	0.300
	SD	0.875	1.23	0.412	43.4	0.814	256	111.5	0.05
	CV %	6.39	4.29	4.61	20.56	16.51	16.40	16.6	19.23
	Q 1	13.2	27.9	8.5	173.9	4.20	1334	573.1	0.236
	Q 3	14.4	29.6	9.3	242.2	5.60	1751	762.5	0.311
	Skewness	-0.08	-0.09	-0.48	-0.11	-0.01	-0.03	-0.10	-0.94

Among the outputs of the FIBROTEST device are graphs showing the distribution of each cutting process and the limits of elongation and strength. It is clear from Figures 1 and 2 that the values of strength and elongation are higher for long / strong than for short / weak cotton. It is also noted that the distribution of fibers during cutting was more uniform for short / weak than long / strong.

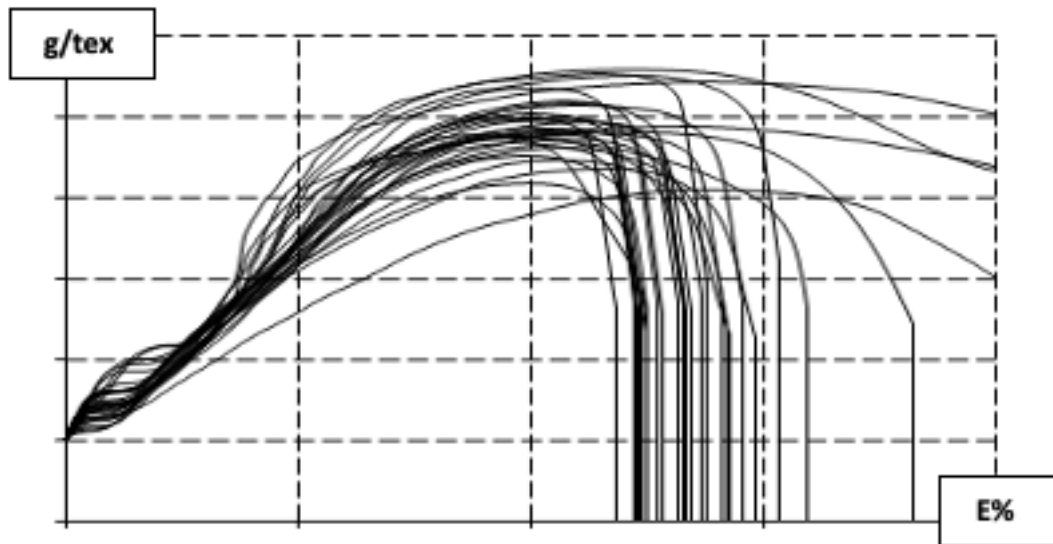


Figure 1. The effect of Force on strength elongation for long/strong

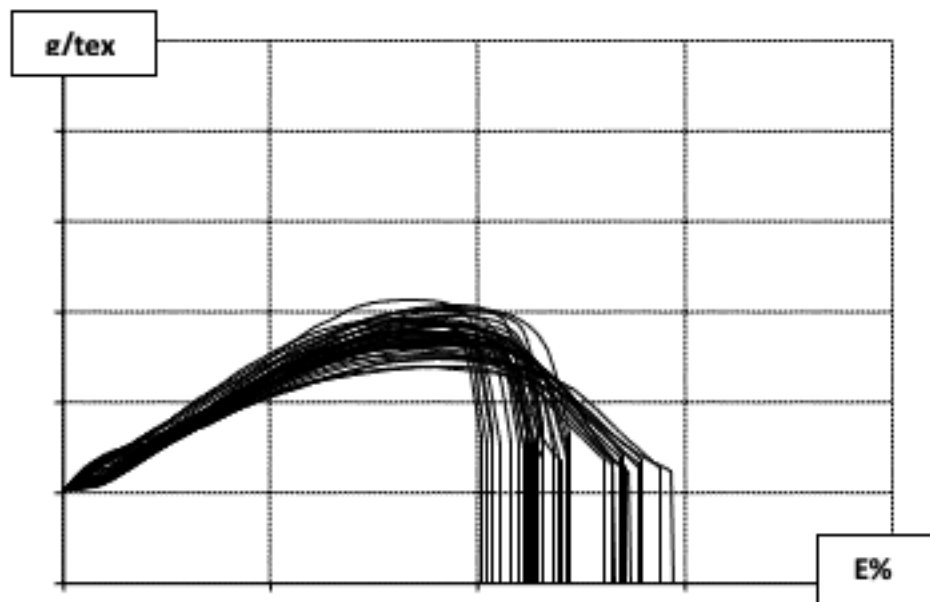


Figure 2. The effect of Force on strength elongation for short/weak

The influence of length and strength with effective measures

It is important to recognize the pattern of the population under study by examining the magnitude of the association which can often be influenced by the selection of individuals

observed. Table 6 exhibits the relation of BW, LD, Force, Work and Time with fiber length and strength measurements for long/strong standard cotton.

Regarding cotton fiber length distribution measurements, there are significant relations with the influencing factors, although there are significant correlations of some, such as the positive relation with 50 % SL and length uniformity, and the negative association with short fiber index with Force and work. Abs-STR and Rel-STR exhibit significant correlation coefficients with BW, LD, Force and work and insignificant correlation with Time. Whereas, correlations of E % with BW and LD are insignificant, and significant with other measures. All of these correlations are positive moderate values.

Table 6. Correlations between length & strength and their contributors for long/ strong standard cotton

Length/strength Properties	Length properties										Strength properties		
	UH M	Rel - UH M	2.5 % SL	ML	50% SL	UI	Rel- UI	UR	SF C	SFI	Abs-STR	Rel-STR	E %
BW	-0.072	-0.067	-0.059	0.094	0.180	0.195	0.191	0.238	-0.091	-0.113	0.415**	0.414**	0.273
LD	-0.073	-0.067	-0.060	0.089	0.174	0.189	0.184	0.231	-0.086	-0.109	0.407**	0.406**	0.272
Force	0.027	0.036	0.041	0.273	0.382**	0.396**	0.391**	0.435**	-0.273	-0.296*	0.667**	0.667**	0.299*
Work	0.070	0.124	0.083	0.271	0.343*	0.359*	0.354**	0.378**	-0.269	-0.285*	0.527**	0.527**	0.730**
Time	0.136	0.150	0.159	0.179	0.158	0.165	0.162	0.142	-0.177	-0.171	0.235	0.231	0.705**

Table 7 shows the relation of BW, LD, Force, Work and Time with fiber length and strength measurements for short / weak standard cotton. Whole cotton fiber length distribution measurements whether at CCS or HVI mode, do not show any significance of correlations with BW, LD, Force, Work and Time. On the other hand, correlations of Abs-STR and Rel-STR are highly significant, while correlations of E % are insignificant.

Table 7. Correlations between length & strength and their contributors for short/ weak standard cotton

Length / strength Properties	Length properties										Strength properties		
	UH M	Rel-UH M	2.5 % SL	ML	50 % SL	UI	Rel-UI	UR	SFC	SFI	Abs-STR	Rel-STR	E %
BW	-	-	-	-	-	-	-	-	0.1	0.1	0.56	0.55	-
	0.2	0.1	0.2	0.1	0.1	0.1	0.1	0.0	56	76	1**	2**	0.0
LD	12	98	05	80	19	02	05	42	0.1	0.1	0.56	0.55	-
	15	01	07	83	21	04	07	43	59	79	2**	4**	0.0
Force	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.0	0.75	0.74	0.0
	0.0	0.0	0.0	0.0	40	53	51	96	08	25	2**	5**	12
Work	87	75	79	26									
	-	-	-	-	-	0.0	0.0	0.0	0.0	0.0	0.63	0.63	0.1
Time	0.1	0.1	0.1	0.0	0.0	02	00	46	52	64	7**	2**	82
	15	03	08	71	14								
	-	-	-	-	-	-	-	-	0.1	0.1	-	-	-
	0.0	0.0	0.0	0.1	0.1	0.1	0.1	0.1	11	14	0.61*	0.61*	0.1
	67	76	72	08	32	41	41	43			*	*	11

Although BW, LD, Force, Work and Time have a significant relationship with fiber strength, the correlation values are not high for long / strong or short / weak standard cottons. This explains the existence of a correlation, but the relationship is not strong, meaning that an increase in the value of one factor does not necessarily lead to an increase in the other factor. This confirms the strong residual effect of the random error on the accuracy of the measurements.

Figure 3 and Figure 4 illustrate the irregular and congruence in the relationship of each of bundle weight and linear density with bundle strength for long / strong and short / weak standard cotton. This is due to the fact that the LD is derived from the BW, as it can be said that linear density expresses bundle weight. It is clear from the two figures that the relationship is neither ascending nor descending. Therefore, fiber strength values do not follow a valuable path of bundle weight and linear density.

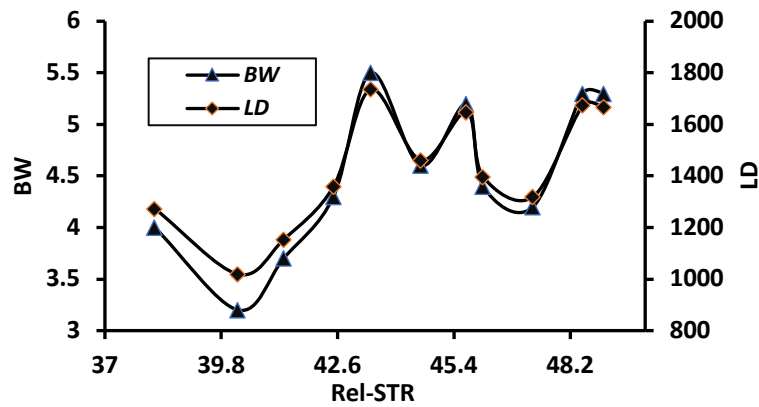


Figure3. The relation of bundle weight and linear density with fiber strength for long / strong cotton

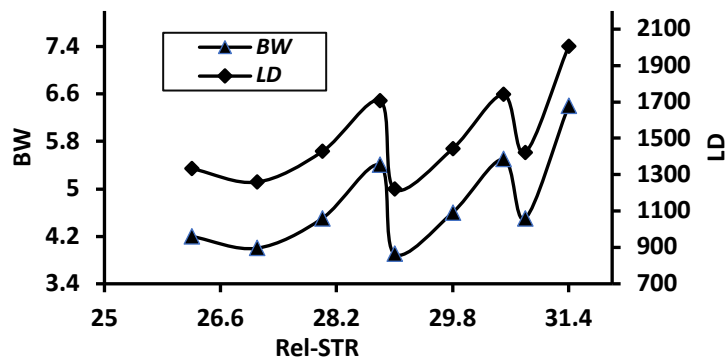


Figure 4. The relation of bundle weight and linear density with fiber strength for short / weak cotton

ACCURACY OF FIBROTEST MEASUREMENTS

In this regard, we present the accuracy of FIBROTEST measurements by comparing the obtained values with the actual ones (μ). Table 8 presents measures of accuracy, .e, deviation ($D = x - \mu$), % error ($\% E = (x - \mu) \times 100 / \mu$) and normalization ($\eta = x / \mu$) of cotton fiber length and strength measurements. It is noted that the accuracy of UHM, Rel-UHM and Rel-STR for long / strong are higher than for the short / weak standard cotton; whereas for UI and Rel-UI, the opposite is the case. UHM looks more accurate than Rel-UHM, whether long / strong or short / weak. UHM is the most accurate in measurement with an error rate of 0.60 %, i.e. 99.4% accuracy for long / strong, while Rel-STR the least accuracy, with an error rate of 11.32 %, i.e. 88.7 % accuracy for short / weak. The normalized values also indicate the accuracy of the measurements, since η for each is close to one, except for Rel-STR, it seems a little far away. It is worth noting that all measurement values obtained from the FIBROTEST are higher than the actual values. Due to the fact that the tests are performed on a rather large number ($N=400$), so we obtained measurements with high accuracy. Certainly, testing a smaller number of subsamples results in lower accuracy. In general, the number recommended by the company Textechno, the manufacturer of the FIBROTEST device, is 6 subsamples. Often the operator may

sometimes find that this is a large number, which may affect the accuracy of the measurement, especially the bundle fiber strength.

Table 8. Parameters of accuracy for length and strength measurements

Sample N=400	Long/strong			Short/weak		
	D	% E	η	D	% E	η
UHM	0.20	0.60	1.01	0.89	3.05	1.03
Rel-UHM	1.44	4.09	1.04	1.43	4.91	1.05
UI	2.00	2.33	1.02	0.94	1.10	1.01
Rel-UI	1.90	2.22	1.02	1.49	1.82	1.02
Rel-STR	1.88	4.43	1.04	2.88	11.32	1.11

Since only the bundle weight and linear density measures are related to personal error and can be controlled, the focus would be on them. It was previously shown that the relationship of bundle weight or linear density with FIBROTEST measurements is neither ascending nor descending order. Therefore, the operator always considers only what the BW or LD value should be achieved to obtain most accurate values for fiber strength. For this, we seek to find the values of bundle weight or linear density that achieves the closest measured value of fiber strength to its actual value. The normal distribution is a theoretical distribution. What you are really testing with the normality test is not whether your data is exactly consistent with a normal distribution, but whether your data is close enough to normal that you can use your statistical tool without concern. Figures 5 and 6 illustrate the graphical summary for linear density value that frequent value of measured fiber strength of long / strong and short / weak that approximately close to their actual values. The Anderson Darling Normality Test (A^2) values for LD of long / strong and short / weak cottons are low (1.64) and P values <0.005 . So values of LD for the frequent measured value of fiber strength are statistically different from the normal distribution. Also, the distributions of linear density are strong in symmetry, as they are almost normal due to the fact that the mean and median values are equal. The values of zero for skewness indicate that the tails of the shape extend the same distance from the mean due to the symmetry of the LD distribution. The small and negative kurtosis value indicates a flatness of the distribution of LD that is slightly less than normal. Other than all of the above, despite the accuracy of the FIBROTEST in the measurement, it should be noted that the practical average of linear density that achieves the actual value of fiber strength is 1723 for the long / strong and 1273.7 for the short / weak cotton.

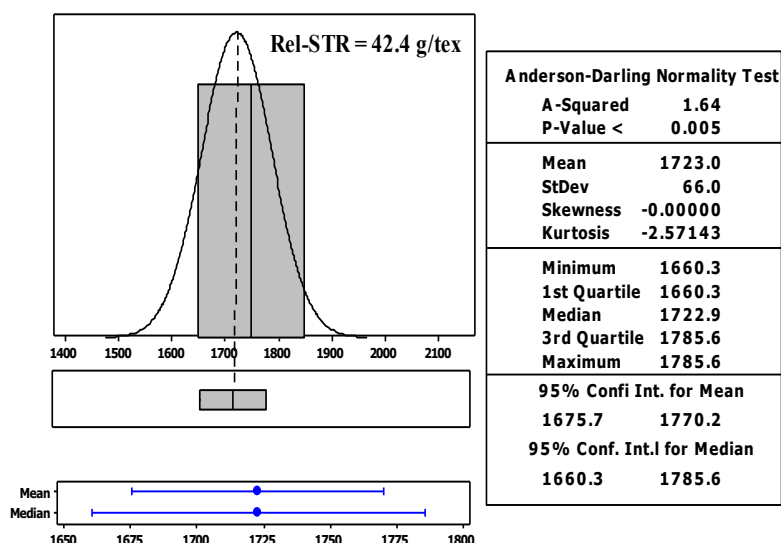


Figure 5. Graphical summary for LD of long / strong cotton

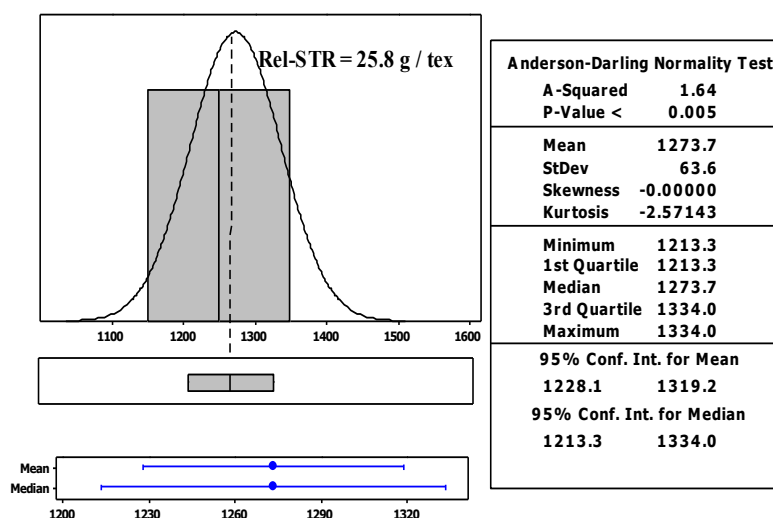


Figure 6. Graphical summary for LD of short / weak cotton

Here, it should be noted that this dilemma always faces operators of devices that depend in their measurement of strength on the weight of a known length of the strand of fibers after cutting, such as Pressley and Stelometer. Therefore, it requires some investigation and development to obtain a general and known average of linear density can be achieves an accurate measurement of fiber strength, whether the fibers are long / strong or short / weak class. Since, in addition to the sensitivity of the operator, the Fibro-sampler is the equipment that is used in preparing samples, so the investigation may focus on its design and dimensions, or make it automatic.

CONCLUSION

After conducting several tests for the cotton fiber length and strength on the FIBROTEST device for samples of long / strong and short / weak standard cottons, it was found that the device is accurate in measurement. But in order to achieve this, a large number of samples should be measured to avoid the dilemma of obtaining the appropriate bundle weight or linear density to achieve the most accurate measurement, especially for fiber strength. It also requires obtaining a value for the bundle weight or the linear density so that it is identical and repetitive to a large extent, with the continuation of measurements. Since the Fibro-sampler is mostly responsible for preparing the sample, the focus in developing the device is on it. This may be by changing the air pressure or adjusting the dimensions of the Fibro-sampler.

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