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DETERMINATION OF A STANDARD SPINNING TECHNIQUE ON THE OPEN-END ROTOR SPINNING SYSTEM FOR ROUTINE TESTING OF LONG-STAPLE COTTONS PART 2: YARN COUNT

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Abstract

The present study was conducted to establish a new standard yarn count for the open-end rotor spinning for routine testing of Long-Staple cottons. Also, twist multiplier; count correction and determination of the number of lea breaks were studied. Five Egyptian Long-Staple cotton varieties namely Giza 80, Giza 83, Giza 90, Giza 85 and Giza 89 were used in this trial.

According to the degree of precision, the nominal count 30s with 4.4 twist multiplier was chosen as an appropriate yarn count based on lea strength variation and optimum quality. Furthermore, ring yarn count level in the Egyptian spinning mills is around 28.5s. The three regression coefficient values of -1.3, -1.5 and –1.9 appeared to be not suitable to be used for correcting the observed lea strength with 30s yarn count since they increased the coefficient of variation in the corrected lea product of tested cottons. The acceptable number of leas for a test was recorded as 24 leas.

INTRODUCTION

Since the commercial introduction of open-end rotor spinning in 1967, it has never ceased to develop. Open-end rotor spinning has superior economical advantage over corresponding ring spinning in the coarse to medium counts. In recent years, there have been many successes to push rotor spinning further into the area of fine yarn count, up to 40s cotton count. In the last twenty years, the average yarn count that produced in the Egyptian spinning mills was around 30s spun from Long-Staple cotton varieties.

Regarding the standard count, Yousef and Abdel-Salam (1969) remarked that in USA, the quality evaluation of tested cottons are usually based on more different standard counts, to enable the American breeders to produce the kind of cotton that tex-

tile industry needs for different end uses. Abdel-Salam (1972) reported that the relationship between the optimum amount of twist inserted and yarn strength is dependent on the balance between the alignment of fibers in the yarn with respect to its long axis and the cohesion between the fibers rather than on yarn evenness. It is well known, that the most important single character of Egyptian cotton is its strength when spun into yarns. Giza ring spinning test mill was established in 1934 in order to keep and improve the spinning quality of the Egyptian cotton up to the highest possible levels. In Cotton Technology Research Division, Cotton Research Institute, Giza the strength of the standard yarn counts, i.e. 60s carded and 60s and 120s combed ring spun yarns with 3.6 twist multiplier, are given in form of lea count strength product, Aboul-Fadl *et al.* (1987). Regarded the setting of a correction factor for standard count, Hancock (1937, 1945), and Kapadia (1934) reported that under spinning-test conditions, fairly large count variations were liable to arise, even though cotton samples were given simultaneous identical treatments. They did not arrive at the same final count. They concluded that accuracy could be improved by correcting the lea count strength product according to the count levels.

The present study was carried out on the Egyptian commercial Long-Staple cottons, firstly, to install appropriate yarn count and twist multiplier as an additional standard count for open-end spun yarns, and secondly, to find out the correction factor that could be used for correcting the observed lea count strength product of this standard count for the deviations in actual count from the nominal count.

MATERIALS AND METHODS

Five Egyptian commercial long-staple cotton varieties belonging to the long-staple category namely; Giza 80, Giza 83, Giza 90,Giza 85 and Giza 89 were used in this study.

Second draw slivers were spun on Auotocoro 288 OE spinning into four yarn numbers i.e., 25 Ne (23.6 tex), 30 Ne (19.7 tex), and 35 Ne (16.8 tex) with twist multiplier (αe) 3.6, 4.0, 4.4 and 4.8 respectively. The spinning conditions for all cotton varieties included a 31 mm diameter rotor (cotton type) running at 100.000 rpm. The second draw passage (0.26 Hank slivers) was processed at opening roller speed for

8200 rpm, as recommended by El-Sayed and Suzan, Sanad (2003). The mean values of fiber length measurements; fiber strength, fiber elongation %, and micronaire value of the studied commercial long staple cottons, are presented in Table 1.

Table 1. Fiber data from tests carried out on 2nd draw sliver.

Cotton variety	Fiber length parameters			Strength (g/tex)	Elongation (%)	Micronaire Reading
	2.50% (mm)	50% (mm)	UR (%)			
G.80	29.5	14.5	49.1	28.5	6.5	4.1
G.83	28.9	14.5	50.0	27.4	6.7	4.2
G.90	29.2	14.7	50.3	28.8	7.0	4.1
G.85	29.5	14.7	49.8	29.5	6.8	3.9
G.89	30.7	15.5	50.4	29.3	6.8	3.9

All fiber tests were conducted on the second card sliver according to ASTM method: (A.S.T.M., D-1440-67) for the fiber length by Fibrograph 530, and (A.S.T.M., D-1445-75, 1984) for the fiber strength by Stelometer and also micronaire reading, fiber fineness and maturity were tested by Micromat (A.S.T.M., D-1448-59, 1984). Yarn strength expressed in terms of lea count strength product (L.C.S.P) was measured by using the Good-Brand Lea Tester. The broken leas were weighed by a Sauter Alfred Balance to estimate its actual count (A.S.T.M., D-1578-67). Yarn uniformity and imperfections were measured on Uster Tester III (A.S.T.M., D-1425-84). For the statistical analyses, the trials were designed as a three-factor full factorial experiment with three replications. The simple regression and correlation coefficient were estimated between data of the actual count as independent variable (X) and the observed lea strength as dependent variable (Y). Also, Confidence limit (C.L.) and Degree of precision (E) and least possible coefficient of variation of the best (E) were used to determine the suitable number of breaks for the standard testing technique. Fiber and yarn properties were determined under standard conditions of 65 ± 2% relative humidity and 21±1°C temperature at the Cotton Technology Research Laboratories, Cotton Research Institute, Giza, Egypt.

The spinning technique described by Hancock (1937) was used in this study to prepare the second draw sliver. The one kilogram sample of each cotton presented for

a spinning test is hand-fed direct to the first card and treatment. After the first card the sliver is wound on to a drum forming a sheet of about 80 ends, which is rolled up into a lap and carded a second time; this lap is weighed and brought to correct weight by removing an appropriate number of ends as it unrolls at second card. The hank of sliver is thus accurately controlled. A revolution counter actuated by the doffer measures off the second card sliver into eight equal lengths ready for drawings. Samples are given two drawings, and usually warp to within a half of 1 percent of correct hank at the final drawing, and then, supplied in to open-end rotor spinning machine.

RESULTS AND DISCUSSION

Lea count strength product

The properties of yarns produced and the spinning specifications are presented in Table 2. and Figure 1. As is well shown, the lea count strength product level is lower at finer counts. The strongest yarns were produced from Delta cottons, followed by Upper Egypt cottons. Yarns from Delta cottons were of similar strength, although Giza 90 cotton Uppers tended to produce a slightly stronger yarn among the Upper Egypt cotton varieties.

Table 2. Measured Lea count strength product at different yarn count.

	G.80	G.83	G.90	G.85	G.89
Yarn count					
25s	2055	2020	2110	2220	2220
30 s	1980	1985	2045	2170	2195
35 s	1870	1910	1940	2065	2050

L.S.D. at 0.05 % probability = 48.05

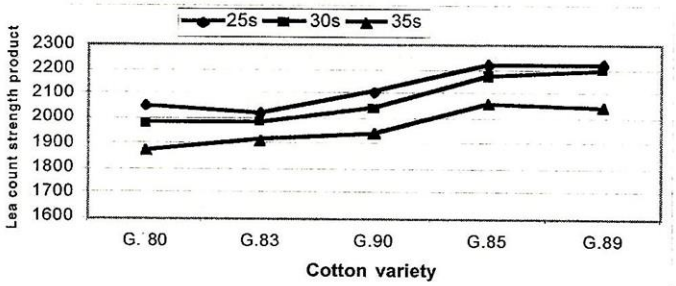

Fig. (1). Relationship between lea count strength product and yarn count for the LS cotton varieties.

The change in lea count strength product as yarn count is increased from 25s, to 30s and from 30s to 35s varied according to cotton variety. The results are shown in Table 3. The variability in lea count strength product due to increasing yarn count from 25s to 30s were generally highest than the change in yarn count from 30s to 35s.

Table 3. The change in lea count strength as yarn count is increased from 25s to 35s.

	G.80	G.83	G.90	G.85	G.89
Yarn count					
25s	100%	100%	100%	100%	100%
30 s	96.35%	98.82%	96.69%	97.74%	98.87%
35 s	94.44%	96.22%	94.48%	95.16%	93.39%

Twist multiplier

The twist multiplier at which test yarns are spun has some influence on lea count strength product as a whole; as noted by Abdel-Salam (1972), who reported that the optimum twist multiplier for the short and coarse variety was greater than for the longer and finer variety. In other word, cottons of low micronaire (high fineness) are found to be relatively stronger at hard twist. The optimum twist multiplier for Giza 80, Giza 90 Giza 89 is 4.4 while, for Giza 83 Giza 85 is 4.8.

Table 4. Measured Lea count strength product at different Twist multiplier.

	G.80	G.83	G.90	G.85	G.89
Twist multiplier					
3.6	1815	1800	1830	2020	2065
4.0	1995	1985	2060	2120	2140
4.4	2040	1995	2145	2230	2265
4.8	2075	2155	2140	2300	2300

L.S.D. at 0.05 % probability = 48.05.

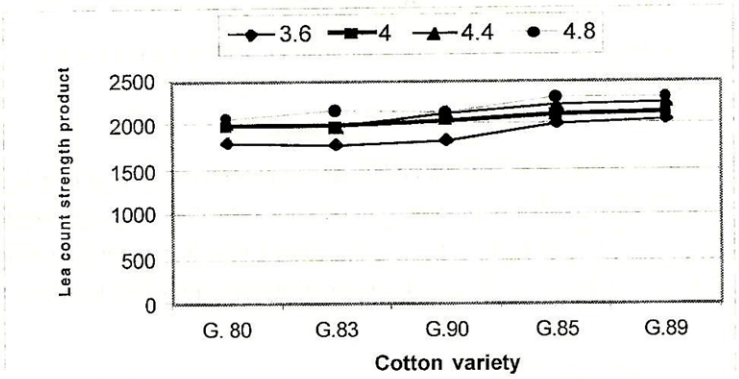

Fig. (2). relationship between twist multiplier and Lea count strength product for the LS cotton varieties.

Coefficient of variation in yarn count and lea strength

According to Table 5., the statistical analysis showed an increase of draft ratio (i.e. reduce the number of fiber in yarn cross-section) would mean increase in yarn count coefficient of variation in 35s. If the count c.v. % is 3.53 % in 25s, then it could be shown that the count c.v. % will be higher than 4.45 % in 35s. Moreover, there is a slight trend for 30s count to show lower c.v. % (3.38) than the respective 25s and 35s.

Table 5. Statistical parameters of the commercial Long-Staple cottons spun on different counts and twist multipliers.

Yarn count	Twist mult.	Count ($\bar{X}$)	C.V.%	C.L.	(E)	Lea strength ($\bar{X}$)	C.V.%	C.L.	(E)	Corr.	Reg.	$T_{Calculated}$
25s	3.6	24.56	3.60	0.16	0.65	78.82	6.90	0.97	1.23	0.119	0.715	1.23Ns
	4.0	24.45	2.74	0.11	0.49	85.16	5.52	0.84	0.98	-0.239	-1.676	2.59**
	4.4	24.82	4.08	0.18	0.72	88.92	7.43	1.18	1.32	-0.284	-1.848	3.10**
	4.8	24.73	3.35	0.14	0.60	91.17	6.25	1.01	1.11	-0.275	-1.898	3.04**
	Total	24.65	3.53	0.15	0.63	86.10	7.31	1.30	1.50	-0.068	-0.573	1.44Ns
30s	3.6	28.63	3.85	0.19	0.68	67.46	7.32	0.88	1.31	-0.377	-1.686	4.27**
	4.0	28.88	3.69	0.18	0.65	72.06	6.22	0.80	1.11	-0.468	-1.970	5.78**
	4.4	28.81	2.88	0.14	0.51	74.78	6.89	0.92	1.23	-0.148	-0.913	1.62Ns
	4.8	27.78	3.04	0.15	0.54	76.84	6.14	0.84	1.09	-0.350	-1.880	4.02**
	Total	28.78	3.38	0.17	0.60	72.89	8.15	1.06	1.45	-0.245	-1.491	5.43**
35s	3.6	24.59	3.48	0.21	0.62	52.01	6.55	0.61	1.17	-0.295	-0.836	2.86**
	4.0	34.74	2.84	0.17	0.50	56.09	5.90	0.59	1.05	-0.188	-0.632	1.97*
	4.4	33.20	4.90	0.28	0.87	61.38	9.03	0.99	1.61	-0.378	-1.290	4.28**
	4.8	33.43	4.47	0.26	0.79	62.05	8.16	0.90	1.45	-0.250	-0.863	2.75**
	Total	33.49	4.48	0.21	0.81	58.24	10.31	1.07	1.84	-0.467	-1.843	10.75**

C.V. % : Coefficient of variation
C.L. : Confidence limit
E : Degree of precision
Corr. : Correlation
Reg : regression coefficient
Ns : No significant
* : Significant at 0.05 % probability level ($T_{0.05}$=1.96)
** : Highly significant at 0.01% probability level ($T_{0.01}$= 2.58)

The relationship between count c.v. % and lea strength c.v. % was calculated by dividing lea strength c.v. % on yarn count c.v. %. The ratio ranged between 2.3 % for 35s to 2.4 % for both 25s and 30s. these results were confirmed by Ratnam *et. al.* (1972) who reported that the average count c.v. % in 70 mills based on 300 tests is 4.7% in fine counts (60s and finer) and 4.1 % in coarse count (36s and coarser).

From Table 5 it is apparent that, degree of precision of 30s yarn count recorded the lowest value (0.60 %) than the 25s and 35s which recorded 0.63% and 0.81 respectively. The same trend was noticed at degree of precision of the lea strength.

Simple correlation and regression coefficient (slope) were calculated for every yarn count and twist multiplier individually, and for every yarn count collectively, (Table 5). It was found that significant differences and negative correlation coefficient of variation between the actual count and the observed lea strength due to the variation in the actual count. In contrast, both 25s with 3.6 twist multiplier and 30s with 4.4 twist multiplier showed no significance, this result emphasized that the actual yarn count c.v.% for both 25s with 3.6 twist multiplier and 30s with 4.4 twist multiplier can be negligible. The significance of limits and the magnitudes of correlation value increased as the range of the actual count increased.

It is essential to recognize the result found above that the standard count 30s and 4.4 twist multiplier being chosen as least in yarn count and lea strength variation and optimum quality. Furthermore, the produced ring yarn count level in the Egyptian spinning mills is around 28.5s, as much as 10-15 percent higher or lower using the Long-staple cotton varieties (Textile consolidation fund, 2001).

Count correction

Under the conditions of open-end spinning test, further correction is necessary, because fairly large counts variations are liable to arise. When second draw-frame slivers of equal hank but different cottons passed through feed roller, opening roller, rotor groove and yarn withdrawal, even though they are given simultaneous identical treatment, they do not all arrive at the same count. This phenomenon can be emphasized that the open-end rotor system is very sensitive for the coefficient of variation in sliver hank.

Statistical parameters estimated from data of the 120 leas spun from five cotton varieties are given in Table 6.

Table 6. Statistical parameters of all varieties under study on 30s open-end yarns.

Count level	Actual count		Lea strength		No. of tests		Correlation and regression coefficient		
	$\bar{X}$	c.v.%	$\bar{y}$	c.v.%	No.	%	c	b	a
Level a (28-32)	28.97	0.73	74.48	4.92	110	91.6	-0.221	-1.34	122.5
Level b < 28	27.40	0.20	77.90	6.25	10	8.3	-0.177	-1.22	108.7
All levels	28.81	0.69	74.78	5.65	120	100	-0.148	-0.91	101.1

c: correlation. b: regression coefficient a: Intercept

Table 7. Statistical parameter of individual varieties under study on 30s open-end yarns.

Cotton variety	Actual count		Lea strength		Correlation and regression coefficient		
	$\bar{X}$	c.v.%	$\bar{y}$	c.v.%	c	b	a
Giza 80	29.42	0.45	69.17	2.90	-0.39	-1.80	122.3
Giza 83	28.23	0.56	72.25	3.21	-0.41	-1.89	18.73
Giza 90	28.46	0.65	75.58	3.05	-0.08	-1.33	84.93
Giza 85	28.81	0.52	79.13	4.12	-0.08	-1.50	64.45
Giza 89	29.15	0.42	77.79	4.11	-0.85	-1.52	138.7

Examining Table 6 and 7., the statistical analysis for the simple correlation showed significant negative correlation coefficient between the actual count and the observed lea count strength, taking into consideration the other factors which influenced the observed lea strength i.e., fiber properties and spinning system. To select the appropriate b values intended to correct the observed lea strength of the 30s open-end yarns to the strength of these new standard, a set of three values of b: -1.3, -1.5, and –1.9 was used (Table 8.).

Generally, it was found that the three regression coefficient values of -1.3, -1.5 and –1.9 appeared to be not suitable to be used in correcting the observed lea strength with 30s yarn count because of the increase in the coefficient of variation of the corrected lea product of tested cottons. This result is under standably due to the limited deviation of actual counts from 30s yarn count.

Table 8. Comparison between different correction factors.

Cotton variety			Corrected Lea product					
	Uncorrected Lea product		1.3		1.5		1.9	
	$\bar{X}$	c.v.%	$\bar{X}$	c.v.%	$\bar{X}$	c.v.%	$\bar{X}$	c.v.%
Giza 80	2030	3.68	2060	3.9	2055	3.9	2040	3.8
Giza 83	2035	4.51	2110	4.4	2085	4.4	2070	4.4
Giza 90	2150	3.05	2220	3.6	2210	3.6	2195	3.5
Giza 85	2280	4.01	2335	4.4	2310	4.6	2290	4.7
Giza 89	2265	3.70	2305	4.5	2295	4.5	2275	4.5

Determination of the total number of leas tested

According to the Confidence limit and Degree of precision as shown in the equation:

Confidence limit (0.95 significant level = 1.96 X Standard Deviation / $\sqrt{n}$

Degree of precision = confidence limit/ average X100

It could be seen from Table 9, that the degree of precision decreased markedly when total number of leas tested are increased from 6 to 48 leas. The deviation between the Degrees of precision at the same number of lea testing comprises to the real differences between the cottons fiber properties in the two locations (Upper and Delta).

Table 9. Degree of precision at different numbers of leas tested.

No. of tests	Upper Egypt cottons (G. 80, 83 and 90)	Delta cottons (G, 85and 89)
6	2.10	2.15
12	2.02	1.76
18	1.52	1.59
24	1.32	1.25
48	1.20	1.10

However, it is rather interesting to note that the 24 lea testing is acceptable number of test and optimum of degree of precision since the change form 24 lea testing to 48 lea test was lower than the change from 18 to 24 lea testing.

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تحديد طريقة اختبار قياسية لتقييم الأقطان المصرية الطويلة على نظام غزل الطرف المفتوح الجزء الثاني: نمرة الخيط

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معهد بحوث القطن – مركز البحوث الزراعية – الجيزة

استهدفت هذه الدراسة تحديد نمرة قياسية جديدة للأقطان المصرية الطويلة المغزولة على نظام غزل الطرف المفتوح ، كما تمت دراسة كلا من معاملات البرم ومعامل تصحيح النمرة وتحديد عدد الشلل المراد اختبارها . استخدمت لهذه الدراسة خمسة أصناف من القطن المصري طويل التيلة هي جيزة ٨٠ ، جيزة ٨٣ ، جيزة ٩٠ ، جيزة ٨٥ وجيزة ٨٩ .

أظهرت النتائج أن النمرة القياسية المناسبة هي نمرة ٣٠ انجليزى بمعامل برم ٤,٤ وقد اختيرت بناءا على اختبار درجة الدقة ، كما أنها اقل معامل اختلاف لكل من النمرة ومعامل البرم ومتانة الشلة وذات مستوى جودة مقبول علاوة على ذلك ، فان متوسط النمرة المغزولة في مصانع الغزل المصرية على نظام الغزل الحلقي تدور حول ٢٨,٥ انجليزى وقد تزيد أو تنقص بنسبة ١٠-١٥٪ باستخدام الأقطان المصرية الطويلة . أوضحت قيمة معاملات الانحدار (-١,٣ ، -١,٥ ، -١,٩) أنها غير مناسبة لاستخدامها كمعامل تصحيح للمتانة الفعلية على نمرة ٣٠ انجليزى وان انسب عدد للشلل المختبرة هو ٢٤ شلة.