OPEN-END ROTOR SPINNING OF EGYPTIAN LONG-STAPLE AND UPLAND MEDIUM STAPLE COTTONS

EL-SAYED M. A. M.

Cotton Research Institute. Agricultural Research Center. Giza. Egypt

(Manuscript received September, 2002)

Abstract

Frequency of yarn breakage and spinning limits of open-end rotor yarns produced from five Egyptian commercial cottons and one Upland cotton differing in fiber fineness, strength and length were investigated. A series of different four progressively finer yarn counts were produced from the same cotton at twist multiplier constant (4.8). The obtained results revealed that : For the long staple Egyptian cottons, a minimum of 90 fibers in the open-end yarn cross-section is needed in rotor spinning. These numbers, however, is not constant, but it varied according to modern spinning units, and processing conditions. The Egyptian cotton breeder should pay more attention to produce a new fine, strong and short staple cotton cultivar's to be capable for spinning higher quality open-end fine yarn counts at acceptable level of spinning performance.

The Egyptian commercial cotton varieties exhibited higher spinning performance and yarn strength (lea count strength product) than the Upland MS cotton due to their superior fiber quality especially fiber strength.

INTRODUCTION

The importance of a low end breakage rate in any spinning system is clearly apparent to spinners as the spinning potential, normally guided by end breakage rate, has significant effects upon production volume, cost, and quality of the product.

Feigenberg *et.al*, (1970) reported that in order to ensure normal operation of a BD 200 spinning machine, yarn breaks must not exceed 50/1000 rotor hours. El-Messiry (1977) indicated that the economic effectiveness in spinning Egyptian cotton was found to fall rapidly at a breakage rate exceeding 500 ends/1,000 rotor hours. Simpson and Murray (1978) reported that the fiber properties most suitable for ring spinning, might be not necessarily those most suitable for open-end spinning. Very good open-end yarn strength can be obtained with low-micronaire, and high strength cottons. Avrorov and Privalov (1983) recommended that yarns with a linear density of 29.4 tex (Ne 20) be spun on PPM rotor spinning machines at rotor speed of 60,000 rpm. with 40 breakages / 1,000 rotor hours. Griffin and Mangialardi (1983) stated that the spinning potential yarn count indicates the finest yarn count that can be spun from a cotton sample without any end-breakage when using specific processing procedures. Soliman (1985) reported that using a low micronaire cotton impaired yarn appearance but improved yarn end-breakage rate, especially at high twist. Also, the finest count showed a high end-breakage. Nomeir *et.al* (1987) showed that fiber breakage in yarn depends on their lateral pressure and on the coefficient of friction between them, because yarn structure will be more compact and fibers become close to each other. Lord (1992) reported that the direct consequences of the defects and end breakage are the loss in quality of the product and the increase in labor costs in spinning and in post spinning operations. Deussen (1992) illustrated that the fiber fineness plays a vital role in cotton spinning, since the number of fibers in yarn cross-section determines the spinning limit, yarn quality and spinnability (spinnability at acceptable rate of ends down). Faerber (1993) found that the yarn breakage frequency exhibited a hyperbolic characteristic over the count range. The spinning limit of that particular raw material can be determined employing yarn breakage function. Variations in spinning performance between different cottons can be attributed to the effects of fiber fineness in millitex, assessed with the IIC-Shirly fineness and maturity tester, and the upper half-mean length. In rotor spinning, a minimum of 100 fibers in the yarn cross-section is needed. Abdel-Salam (1994) reported that the spinning limit and yarn count for ring spun yarns are largely dictated by fiber length and fineness, as both characters control the number of turns per inch in which the fiber shares and the number of fibers in the yarn cross-section and, consequently, fiber cohesion and the percentage of fiber length sharing to yarn strength. El-Sayed (2000) studying the end-breakage in ring spinning system, he concluded that a minimum of 70 fibers in the carded yarn cross-section is needed for Long Staple Egyptian cotton varieties.

The major objective of this study was to determine the spinning performance and spinning limit for the Egyptian commercial long staple cotton varieties and comparing it with that for Upland cottons which are usually used cotton in open-end rotor spinning.

MATERIALS AND METHODS

Five long staple Egyptian commercial cotton varieties namely; Giza 80, Giza 83, Giza 85, Giza 89 and Giza 86, in addition to an Upland cotton (obtained from Greece) exhibiting three levels of fiber strength and fiber length were used in this study. Fiber data given in Table 1 show that the Upland cotton was of lower strength and shorter length than all the Egyptian cotton varieties.

Fiber and yarn properties were determined according to ASTM standard. (ASTM, D-1440-67) for the fiber length by Fibrograph 630, and (ASTM, D-1445-

75, 1984) for the fiber strength by Stelometer and also micronaire reading, fiber fineness and maturity were tested by Micromat (ASTM, D-1448-59, 1984). Yarn strength expressed in terms of lea product(lea count strength product) was measured by using the Good-Brand Lea Tester. Yarn uniformity and imperfections were measured on Uster tester III (A.S.T.M., D-1425-84). Fiber and yarn properties were determined under standard conditions (65±2% relative humidity and 21±1C temperature) at the Cotton Technology Research Laboratories, Cotton Research Institute, Giza, Egypt. The test results are given in Table 1.

Table 1. Fiber properties measured on card sliver

MaterialTest results	G.80	G.83	G.85	G.89	G.86	Upland cotton
2.5% S. L. (mm)	29	29.4	30.2	30.9	32.8	25.2
50% S.L. (mm)	14.6	14.5	14.8	15.3	16	12.02
U.R. (%)	50.3	49.4	49	49.6	48.8	47.2
Strength (g/tex)	28	28.14	30.3	30.37	32.7	19.64
Elongation (%)	6.6	6.5	6.4	6.4	6.4	5.3
Micronaire	4.1	4.3	3.7	3.8	3.8	4.6
Maturity (%)	85	87	93	92	84	93
Fineness (mtex)	165	168	141	153	154	168

The six cottons were processed through carding machine. The second card sliver was supplied to the Schlafhorst Auotocoro 288 OE spinning spinbox SE 9 (maximum yarn count 40 Ne) using a 31 rotor diameter (cotton type rotor) running at 100,000 rpm. at opening roller speed for 8200 rpm. A series of four progressively finer yarn counts were spun from the same cotton at twist multiplier constant (4.8). The total number of ends down per 24 rotor hours for each yarn count was recorded and adjusted to 103 rotor hours on screen display at the machine informator.

RESULTS AND DISCUSSION

Table 2 shows the breakage rate and lea product obtained of the six cottons under study, spun into the various yarn counts. The yarn count variation (c.v.%) increased, as the yarn became finer. This result holds true for all cotton yarns. The open-end rotor method allows very high draft (especially in fine count) and enables yarn to be spun direct from sliver, but high draft causes high yarn count variation.

Naturally, breakage frequencies per 103 rotor hours increases and lea product decreases, as yarn counts become finer, Table 2 and Figure 1. In general,

Figure 1 shows a group of curves, which are visibly, seem alike, but with different locations with respect to the abscissa.

There are only two causes of yarn breakage in open-end rotor spinning, apart from the impurities in the rotor groove, either the strength of the yarn is too low to enable it to withstand the normal tension, or the tension is too great for the normal strength of the yarn. Generally, fiber strength, length and micronaire reading are representative for each production area. When cottons are rotor-spun into the same yarn count under identical spinning conditions, the resultant yarn strength varies quite widely. It should be realized that the Egyptian commercial cotton varieties exhibited higher spinning potential and lea product than the respective Upland cotton due to their superior fiber quality (fiber strength, micronaire reading and fiber length). Evidently, the Giza 85 variety showed the highest spinning potential among the Egyptian cottons under study.

From another point of view, Figure 2 showed the lea product for average 35's yarn count. The yarns spun from Giza 85 and Giza 86 cottons tended to have the highest lea product followed by yarn spun from Giza 89. Giza 80 and Giza 83 cottons lea product were of similar order, while the Upland cotton yarn recorded the lowest lea product because of its lower fiber strength. Also, lea product (yarn strength) was influenced by fiber fineness and fiber length, shorter staple and higher micronaire reading which meant higher fiber coarseness.

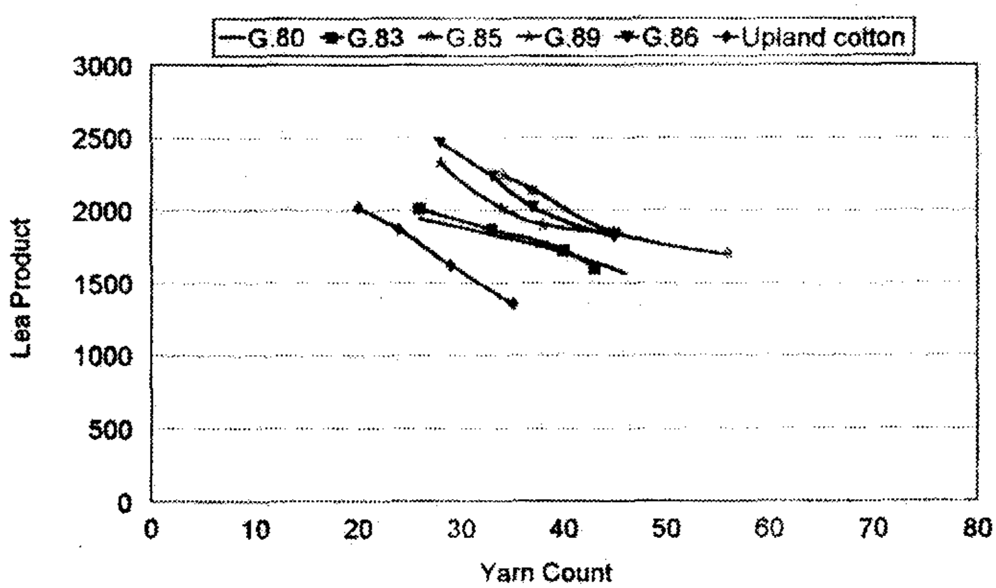

Fig 1. Relationship between yarn count and lea product

Table 2. Recorded number of end breakages and lea product.

Cotton variety	Actual yarn Count (Ne)	Actual yarn Count (Tex)	Count Variation (c.v%)	No. of end breakages (per10^3 rotor hours)	Lea product
G. 80	26	22.7	2.65	0	1945
	35	16.8	3.08	0	1800
	40	14.7	3.9	0	1710
	46	12.8	4.6	62	1565
G. 83	26	22.7	2.35	0	2010
	33	17.9	3.02	0	1870
	40	14.7	3.85	28	1725
	43	13.7	4.39	79.2	1600
G. 85	34	17.3	2.63	0	2250
	37	15.9	3.18	0	2140
	45	13.1	4.68	0	1850
	56	10.5	7.65	24.4	1700
G. 89	28	21.1	2.81	0	2330
	34	17.3	3.04	0	2015
	38	15.5	3.14	0	1900
	45	14.4	4.53	56	1860
G. 86	28	21.1	2.52	0	2465
	33	17.9	2.78	0	2240
	37	15.9	3	0	2020
	45	13.1	4.58	50	1820
Upland cotton	20	29.5	2.2	0	2020
	24	24.6	2.35	0	1870
	29	20.3	2.57	53	1625
	35	16.8	2.98	143	1355

The spinning limits of the studied varieties were calculated using a given maximum tolerable end breakage (No. of end breakage +1 to avoid 0 break) and plotted in Fig.3. The 20 breaks per 103 hour level chosed as a basis however, this number is variable according to the respective production conditions. The results are shown in Table 3 and presented in Figure 4.

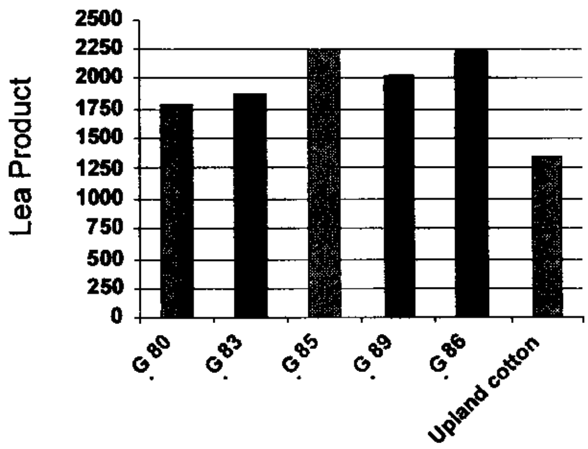

Fig. 2. Lea product for yarn of count 35s.

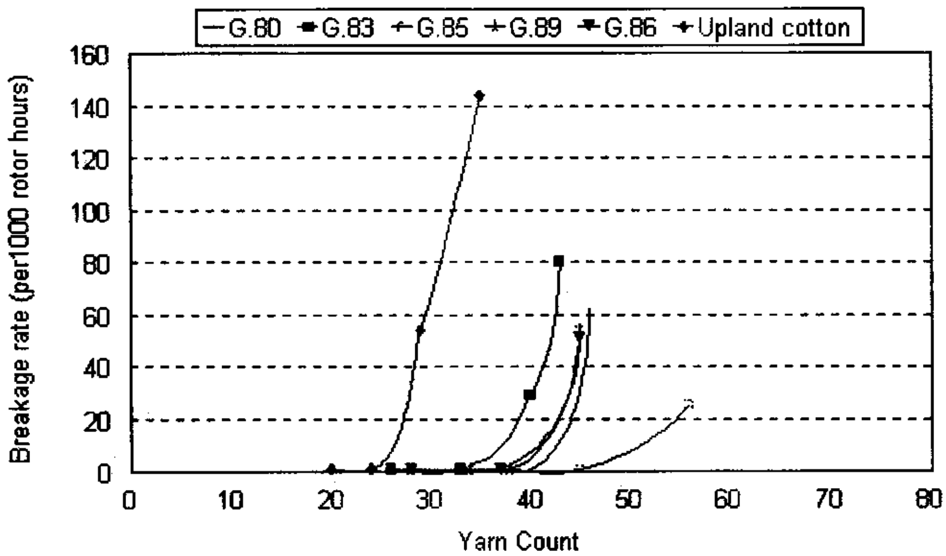

Fig. 3. Relationship between end breakage rate and yarn count.

Table 3. Actual spinning limits at 20 breaks per 10^3 rotor hours

Cotton variety	Yarn count (Ne)
G. 80	43
G. 83	39
G. 85	54
G. 89	43
G. 86	43
Upland cotton	26

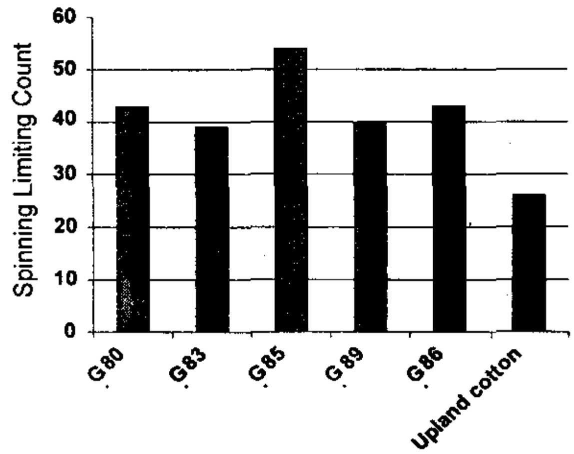

Fig. 4. Actual spinning limits

From many studies it is now known that fiber lower micronaire leads to higher yarn strength in rotor spinning. More important, higher fiber fineness, i.e. lower linear density in millitex leads to better spinning performance, i.e. lower end breaks. According to these results, fiber fineness is one of the most important factors in defining rate of end breaks behavior and spinning limit through its relation to number of fibers in yarn cross-section. The number of fibers in the yarn cross-section was obtained by dividing yarn Tex on fiber Tex in Table 4, which explains what was previously mentioned that the finest yarn could be spun from Giza 85 due to its lower fiber density, and the other Egyptian cotton varieties recorded the same trend towards the spinning limit, while, the Upland cotton recorded the highest number of fibers in yarn cross-section (135), Table 4.

For the long staple Egyptian cottons, it could be stated that in open-end rotor spinning, a minimum of 90 fibers in the yarn cross-section is needed. This number, however, is not constant, but it varies with the processing conditions and design and geometry of the spinning unit.

Table 4. Number of fibers in yarn cross-section.

Cotton variety	Yarn count		Number of fibers in yarn cross-section
	(Ne)	(Tex)	
G. 80	43	13.7	83
G. 83	39	15.1	89
G. 85	54	10.9	77
G. 89	43	14.7	89
G. 86	43	13.7	89
Greece cotton	26	22.7	135

The interrelationships between available fiber properties, yarn count and rate of end breaks was analyzed using multiple regression techniques. Yarn count was used as the dependent variable. The multiple correlation coefficient and the coefficient of determination were found to be (r = 0.934) and (r2 = 0.873) respectively. The regression equation is shown in Table 5.

Table 5. Regression equation to predict the spinning limit.

Regression Equation	R^2	R
$YC = 171.546 - 0.359\ X_1 + 0.099\ X_2 + 5.252\ X_3 - 7.584\ X_4$	0.934	0.873

Where:

YC: Yarn count (Ne).

X1 : fiber fineness (linear density in millitex).

X2 : No. of end breakages (per10^3 rotor hours) .

X3 : fiber tenacity (g/tex).

X4 : fiber 2.5% span length (mm).

In Table 6, the actual spinning limit is given as well as the predicted spinning limit, using the previous equation. Evidently, such model, based on average fiber fineness, number of end breakages (20, 30, 40 and 50 breaks) per10^3 rotor hours, fiber strength and fiber length (2.5% span length), is useful in generating reliable estimates for the spinning limits of various cottons.

Table 6. Actual and predicted spinning limits at different rates of end breaks.

Cotton variety	Actual Yarn count (Ne) at 20 Breaks	Predicted yarn count (Ne) at different breakage rates			
		20 Breaks	30 breaks	40 breaks	50 breaks
G. 80	43	41.5	42.4	43.4	44.4
G. 83	39	38.8	39.7	40.7	41.7
G. 85	54	53	-	-	-
G. 89	43	43	44	45	-
G. 86	43	41	42	43	44
Upland cotton	26	25.2	26.1	27	28

* 50 breaks according to Feigenberg *et.al*, 1970.

It is clear that the high fiber quality Egyptian long staple cottons could be used to produce yarns finer than Upland cotton on the same rate of end breaks.

With regard to the results obtained from this study, it was of prime importance to state finer that the Egyptian cotton breeder should pay more attention to produce new fine, strong and short staple cotton cultivar's capable of spinning higher quality open-end fine yarn counts at acceptable level of spinning efficiency.

REFERENCES

1. Abdel-Salam, M. E. 1994. Fiber characteristics in relation to processing and yarn quality. International Cotton Advisory Committee, Brazil, September. PP:31-35.

2. ASTM. 1984. American Society for Testing and Materials. Standards of textile testing and materials., Philadelphia, Pa.

3. Avrorov, V. A., and I. S. Privalov. 1983 . Use of automatic manipulators for eliminating yarn breakage on rotor open-end spinning machines. Tekhnologiya tekstil_oi promyshlennosti, 4, (154) : 9-12.

4. Deussen, H., 1992. Improved cotton fiber properties the textile industry's-key to success in global competition. presentation to the " Cotton fiber cellulose, structure, function and utilization conference" October 29-1992. Radisson Plazza Hotel Savannh, Georgia 1-24.

5. El-Messiry, M. A., 1977. Open-end spinning and labour requirements. Magyar textiltechnika, (1) : 4-8.

6. El-Sayed, M. A. M. 2000. Physical, structural and mechanical fiber properties in relation to the potential spinning performance and yarn quality of some Egyptian cotton. Ph.D Thesis Fac. Of Agric. Alex. Univ

7. Faerber, C., 1993. How fiber properties affect rotor spinning performance and potential. Presentation to the textile processing conference. Schlafhorst AG & Co., 1-20 Moenchengladbach, Germany.

8. Feigenberg, A. L., V. A., Toroptsev and N. A. Khudyakova. 1970 Improving the quality and reducing the breakage frequency of yarn on BD-200 machines. tekstil'naya promyshlennosti, 30, (8) : 41-43.

9. Griffin, A. C., and G. J. Mangialardi. 1983. Lint retrieval at ginning: further study of bale value and spinning performance. Tex. Res. J., 53: 92-97.

10. Lord, P. R., 1992. Waste in cotton spinning. Cotton Textile Processing , Beltwide Cotton Conferences 1244- 1245.

11. Nomier ,A. A.; M. S. Garawain,; Nafisa Ahmed, T. and M. A. Abdél-Mohsen. 1987. Investigation on cotton fiber and yarn tensile properties using different test speeds. Annals of Agric. Sc., Moshtohor, 25 (2):757-775

12. Simpson, J., and M. F. Murray. 1978. Effect of cotton fiber fineness and strength on mechanical processing and open-end spinning and yarn properties. Tex. Res. J., 48: 270-276.

13. Soliman, A. S., 1985. Factors affecting rotor spinning of fine cotton yarns. Ph.D. dissertation, Texas Tech Univ. USA

الكفاءة الغزلية للأقطان المصرية طويلة التيلة والقطن الأبلند المغزولة على نظام غزل الطرف المفتوح

محمد عبد الرحمن محمد السيد

معهد بحوث القطن - مركز البحوث الزراعية - الدقي - الجيزة

تم دراسة معدل القطوع وحدود الغزل لعدد خمسة أصناف من القطن المصري طويلة التيلة وصنف قطن أبلند مختلف في خواص النعومة والمتانة وطول التيلة على نظام غزل الطرف المفتوح، وقد تم غزل أربع نمر غزلية متدرجة نحو النمرة الأرفع على معامل برم ثابت (٤.٨) ويمكن تلخيص النتائج كما يلي:

في القطن المصري طويل التيلة المغزول على نظام الغزل ذو الطرف المفتوح أقل عدد من الشعيرات في المقطع العرضي هو ٩٠ شعرة. وهذا العدد ليس عدد ثابت ولكن يمكن أن يتغير تبعاً لهندسة وتصميم أجزاء وحدات الغزل ذي الطرف المفتوح، وكذلك ظروف التشغيل. يجب على مربي القطن المصري في معهد بحوث القطن أن يعطي مزيداً من الاهتمام نحو إنتاج صنف جديد ناعم ومتين ومتوسط التيلة ليكون مناسباً للغزل على نظام الغزل ذي الطرف المفتوح بحيث يعطي جودة أفضل ونمرة أرفع ومستوى مناسب من الكفاءة الغزلية.

الأقطان المصرية التجارية أظهرت كفاءة غزلية ومتانة شلة أعلى من القطن الأبلند وذلك لتميز خواص تيلتها ويمكن غزلها على نمر أرفع عند نفس مستوى عدد القطوع.