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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 1: PROCESSING VARIABLES

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Abstract

This study was carried out to determine the processing variables i.e., sliver variables, rotor speed and rotor diameter more appropriate for spinning Egyptian long staple cottons on the open-end rotor spinning machine in routine testing and quality evaluation of different cotton strains especially those included in the breeding programme carried out by the CRI. Giza 83 long-staple cotton variety was spun into 30s yarn count at 4.2 twist multiplier at various rotor speeds and rotor diameters and also, sliver variables. The essential findings of this study could be summarized as follows:

1. A significant improvement in lea count strength product, unevenness and yarn imperfections occurs with the increase in the drawing passage. The improvement in yarn properties is also greater in case of second draw frame passage compared to the first draw passage and card sliver.

2. A 31mm-diameter rotor tended to produce stronger, more even and less yarn imperfections than a 33mm and 40mm-diameter rotors.

3. Acceptable yarn quality was attained at a rotor diameter of 31mm. running at 100,000 rpm.

4. Therefore it is concluded that in the standard technique drawing passage, 31mm-diameter rotor and 100,000 rpm. rotor speed are appropriate.

INTRODUCTION

The Egyptian cotton materials included in the various programmes especially breeding the new varieties are currently tested in the Cotton Technology Research Laboratory, Cotton Research Institute, Giza, according to lea count strength product of the 60's carded yarns with 3.6 twist multiplier spun on the ring spinning system since it was established,(Hancock 1937), chosen as a happy standard yarn construction for comparing the yarn strength levels of the Egyptian cottons. The choice of yarn count was based on being appropriate for ELS and LS as it impractical to use more than one yarn construction. Nowadays, Cotton Research Institute possessed open-end spinning system to evaluate and test the quality properties for long-staple varieties to help cotton breeder in Cotton Research Institute in breeding new varieties more appropriate to open-end rotor spinning.

Regarding the spinning variables of open-end spinning, Grosberg and Mansour (1975) using a single 46-mm-diameter rotor studied the effect of speeds from 30,000 to 100,000 rpm. on yarn properties. They found that strength generally increased but elongation at break decreased, and that weight per-unit-length variability increased. Artzt and Schenek (1977) investigated the effect of rotor diameter, yarn count, and rotor speed on the minimum twist level. Rotors having diameters of 45, 55, and 65 mm over a yarn count range of between 25 and 125 tex (Ne 4 and 24) with rotor speeds from 45000 to 65000 rev/min., were used. Results showed that fine yarns should be spun on small rotors; while larger rotors were suitable for coarse yarn. Simpson (1978) reported that strength of the open-end yarns from double-carded sliver is greater than from single-carded sliver. Simpson and Patureau (1979) discuss the effect of rotor speed (25,000 to 60,000 rpm.) and rotor diameter (46 and 56 mm). They reported that the large-diameter rotor, fast rotor speed produce yarn with poorer fiber orientation and short-term uniformity. Vila *et al* (1982) stated that conventional two-stage drawing improved yarn evenness and reduce the incidence of slubs and other imperfections. El-Sayed (1996) stated that the increase in yarn strength of lower rotor diameter may be appreciably contribute to the recent trends of improving open-end rotor spinning technology which were directed towards reducing rotor diameter and increase rotor speed. Tyagi *et al* (1999) observed that the yarn spun with slivers from second draw frame show less deterioration in evenness than the slivers with one passage. El-sayed and Abdel-Gawad (2001) reported that the too high an opening roller speed (9500 rpm) leads to excessive fiber breakage, thus reducing in upper quartile length and mean length accompanied by increasing in short fiber less than $1/2$ or 3/8 inch. Oxenham (2002) showed that the yarn strength and evenness deteriorate gradually with faster and smaller rotors.

The present study reports the influence of sliver preparation, rotor diameter and rotor speed on the properties of open-end rotor spun yarns, in an effort to select the more appropriate processing variables for a standard method.

MATERIAL AND METHODS

The effect of rotor diameter, rotor speed and sliver preparation on yarn quality was investigated. Giza 83 cotton variety (29.4 mm fiber length, 49.4 UR %, 28.14 g/tex fiber strength, 7.5% elongation, 4.3 micronaire reading and 168 m/tex fineness) was used in the present study and spun on constant yarn count 30's with 4.2 twist multiplier. A Schlafhorst Auotocoro 288 OE was used to study the effect of rotor diameter 31 mm (running at 80, 100 and 120 X 10^3 rev/m.), 33 mm rotor (running at 60, 80, and 100 X 10^3 rev/m) and 40 mm rotor (running at 40, 60, and 80 X 10^3 rev/m). Table 1 lists the spinning parameters for open-end rotor spun yarns in this study. The opening roller speed was 8200 rev/m. To determine the impact of silver preparation, the second card slivers were divided into three portions: (1) second sliver card, (2) slivers with one passage of drawing and (3) slivers with two passages of drawing.

Table 1. Processing variables for open-end rotor spun yarns.

Yarn count	Twist multiplier	Sliver variables	Rotor diameter(mm)	Rotor speed (10^3 rev/m.)
		Card sliver		80
30s	4.2	First draw sliver	31	100
		Second draw sliver		120
		Card sliver		60
30s	4.2	First draw sliver	33	80
		Second draw sliver		100
		Card sliver		40
30s	4.2	First draw sliver	40	60
		Second draw sliver		80

Fiber and yarn properties were determined 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 (lea 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 of 65 ± 2% relative humidity and 21±1 °C temperature at the Cotton Technology Research Laboratories, Cotton Research Institute, Giza, Egypt.

RESULTS AND DISCUSSION

Influence of sliver variables

Table 2 gives the test results of yarns spun of the same slivers. Carding was done without autoleveling, no draw frame autoleveler was available for small samples, which led to some variation in the evenness of sliver fed to the feed rolls of the open-end rotor spinning. Increasing the number of drawing passages improves evenness due to improve fiber parallelization, removes hooks and straightens the fibers in the sliver. The effect of the number of drawing passages i.e., card sliver, first drawing sliver, and second drawing sliver on the rotor diameter were studied and tabulated also, in Table 2. The number of drawing passages has a significant effect on the major yarn properties i.e., lea product, unevenness and number of neps. Spinning directly from card sliver gives the lowest lea count strength products and highest unevenness and yarn imperfections. The results exhibited a sharp increase in major yarn properties for both first and second draw passages. This indicated that the first and second draw passages sufficiently improved the fiber parallelization and straightness in the sliver. The improvement in lea product, yarn unevenness and yarn imperfections from 2nd passage over those from card sliver and 1st passage was undoubtedly the results of better fiber parallelization and straightness and separation. In the most cases, it became evident how important the fiber configuration is leading or trailing hooks, as they are always present in the card sliver (which requires a reverse for the card sliver).

Table 2. Summary of main effects.

Rotor diameter	Sliver variables	Unevenness C.V.%		Yarn imperfections (120/Yds)			Lea product
		Sliver	Yarn	Thin places	Thick places	Neps	
31mm.	Card sliver	9.41	14.80^{a}	3	3	31^{a}	1735^{c}
	1st passage	8.47	14.43^{ab}	3	5	26^{b}	1825^{b}
	2nd passage	7.27	13.74^{c}	5	6	23^{c}	1875^{a}
L.S.D. at 0.01 level			0.42	NS	NS	3.67	7.01
33mm.	Card sliver	9.41	15.24^{a}	3	6	34	1680^{c}
	1st passage	8.47	15.03^{ab}	3	5	31	1700^{b}
	2nd passage	7.27	14.37^{c}	2	6	31	1725^{a}
L.S.D. at 0.01 level			0.51	NS	NS	NS	12.15
40mm.	Card sliver	9.41	15.64^{a}	4	7	42^{a}	1615^{c}
	1st passage	8.47	15.41^{ab}	4	6	41^{ab}	1660^{b}
	2nd passage	7.27	15.03^{bc}	3	4	36^{bc}	1695^{a}
L.S.D. at 0.01 level			0.4	NS	NS	5.5	8.03

NS: non signifigant

Table 3. The percentage change in yarn properties when changing from card sliver to 2nd passage draw sliver.

	Lea product	Evenness (C.V.%)	Number of neps
Rotor diameter			
31mm.	+ 8.06%	-7.16%	-25.8%
33mm.	+ 2.67%	-5.72%	-8.82%
40mm.	+ 4.95%	-3.90%	-1428.00%

The change in the major yarn properties as sliver variables were changed from card to 2nd passage varied according to rotor diameter was calculated. The results are shown in Table 3. The variability in lea product, unevenness and number of neps due to using sliver variables from card sliver to 2nd drawing passage were highest for yarn spun vsing 31mm-diameter rotor than both other rotor diameters. The second drawing passage improves the value of the major yarn properties in all cases of rotor diameters.

Influence of rotor speed and rotor diameter

High rotor speeds are necessary for high production. Small rotors must be used to achieve these rotor speeds. Three rotor diameters were evaluated in this study, namely, the 31mmdiameter rotor, 33mm diameter rotor and 40mm diameter rotor. Since the diameter of the rotor differed, the range of speed over which each was run was varied to maintain approximately similar forces on the yarn during formation. Table 4 and figures 1, 2 and 3 presented the effect of rotor speed, and sliver variables on lea product, yarn evenness and imperfections with rotor diameters 31, 33 and 40mm, respectively. For the 31-mm-diameter rotor, lea product generally increases significantly with rotor speed increasing from 80000 to 120000 rpm. On contrast, increasing the rotor speed led to worsening evenness and imperfections. The increase in lea product due to high rotor speeds can be emphasized by the straightening of fibers in the rotor groove. The resulting increase in fiber length contributes to yarn strength. In small rotor diameter, the fiber could be laid straight on the rotor groove and then, the centrifugal forces press the fiber into the rotor groove and the fiber tend to be straightened promoting higher tension on the fibers as they are spun into the yarn. The yarn thus becomes more compact with less loops and fiber ends on the yarn surface. This result explained that yarn imperfections would be more visible in compact yarn than in the yarn produced from low rotor speed. In this respect, Grosberg and Mansour (1975) concluded that yarn strength is slightly enhanced as the rotor speed increased, probably owing to the increase in yarn tension which will also tend to straighten the fibers. Also, Price (1987) showed that the yarn spun from Upland cottons (Texas, Delta, and California) tended to decrease generally in lea count strength product and single yarn tenacity as rotor (33mm–diameter) speed increased from 80 to 100 $x10^3$ rpm. whereas for the Pima cotton (33.7mm.length) yarns it usually increases.

Table 4. Effect of type of sliver and rotor speed on yarn properties

Sliver variables	Rotor speed (10^3rev/m.)	Lea product	Unevenness C.V.%	Imperfections (120Yds) Thin places	Thick places	No. of neps
31mm-diameter rotor						
Card	80	1525	13.68	2	5	22
Card	100	1770	15.05	4	7	28
Card	120	1905	15.67	5	8	43
1st draw sliver	80	1725	13.54	1	4	15
1st draw sliver	100	1815	14.23	4	5	24
1st draw sliver	120	1940	15.54	7	6	40
2nd draw sliver	80	1755	13.03	1	2	15
2nd draw sliver	100	1905	13.62	3	4	20
2nd draw sliver	120	1975	14.57	5	5	34
LSD at 0.01 level		14.62	0.84	3.39	3.34	11.02
33mm-diameter-rotor						
Card	60	1505	14.01	2	3	29
Card	80	1755	15.78	3	3	30
Card	100	1785	15.94	4	10	44
1st draw sliver	60	1555	14.14	2	4	22
1st draw sliver	80	1780	15.13	3	4	31
1st draw sliver	100	1785	15.84	5	8	43
2nd draw sliver	60	1572	13.48	1	5	21
2nd draw sliver	80	1775	14.14	2	5	26
2nd draw sliver	100	1825	15.50	3	8	45
LSD at 0.01 level		18.88	0.64	2.81	3.85	9.88
40mm-diameter-rotor						
Card	40	1470	14.76	2	2	32
Card	60	1625	15.36	3	3	42
Card	80	1755	16.81	4	5	60
1st draw sliver	40	1485	14.62	4	5	33
1st draw sliver	60	1705	15.28	4	3	38
1st draw sliver	80	1790	16.35	5	9	47
2nd draw sliver	40	1515	14.26	1	3	28
2nd draw sliver	60	1750	15.11	2	10	36
2nd draw sliver	80	1815	15.73	3	8	44
LSD at 0.01 level		15.29	1.04	2.38	5.22	9.89

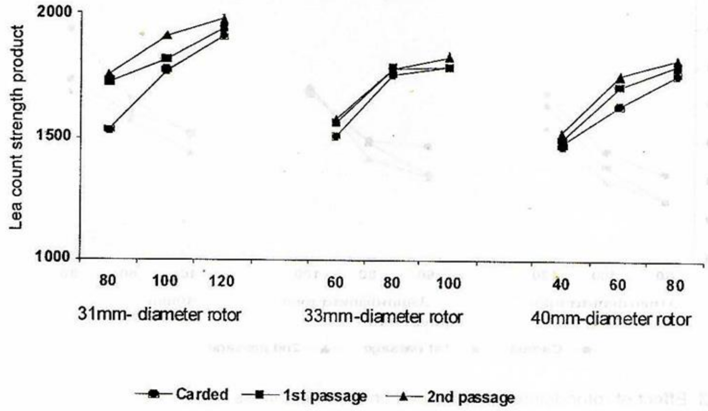

Fig 1. Effect of rotor diameter and speed on lea count strength product

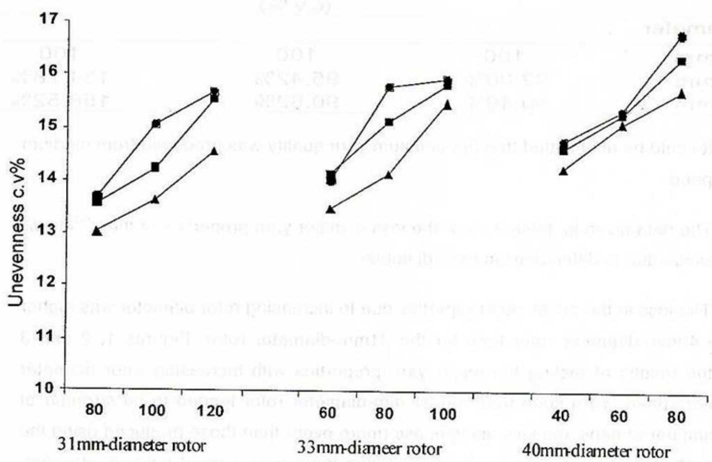

Fig 2. Effect of rotor diameter and speed on yarn unevenness

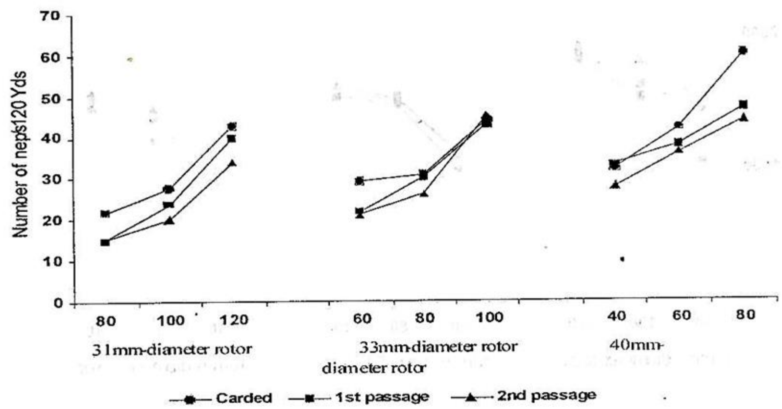

Fig 3. Effect of rotor diameter and speed on yarn neppiness

Table 5. The percentage change of yarn properties for rotor diameter33 and 40mm. compared to rotor diameter31mm.

	Lea product	Unevenness (c.v.%)	Number of neps
Rotor diameter			
31mm.	100	100	100
33mm.	92.00%	95.42%	134.78%
40mm.	90.40%	90.62%	156.52%

It could be also stated that the optimum yarn quality was produced from medium rotor speed.

The data given in table 3 show the loss in major yarn properties of the 2nd drawing passage due to differences in rotor diameter.

The loss in the major yarn properties due to increasing rotor diameter was higher for the 40mm-diameter rotor than for the 31mm-diameter rotor. Figures 1, 2 and 3 show the results of testing the major yarn properties with increasing rotor diameter and rotor speed. Yarn spun from the 31 mm-diameter rotor tended to be stronger of lower number of neps and less unevenness (more even) than those produced using the 33 and 40-mm- diameter rotors, Table 5. Since there was a trend towards stronger, more even and low neps yarns being produced from the smaller rotor (31mm.), the data at 100,000 rpm. however, suggested that the smaller rotor (31mm.), gave significantly lower unevenness than the high speed (120,000 rpm.).

REFERENCES

1. Artzt, P., and A., Schenek. 1977. Minimum twist factor as a reference value for spinning stability during rotor spinning. Textile Praxis International, 32 (8): 910-911 & VII-VIII.

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

3. El-Sayed, M. A. M. 1996. Spinnability of some Egyptian long staple cotton of low quality on the open-end spinning system. M.Sc Thesis Fac. Of Agric. Alex. Univ

4. Grosberg, P. and S. A. Mansour. 1975. High-speed open-end rotor spinning, J. Textile Inst. 66, 389-396.

5. El-Sayed, M.A. and Nadia, S. D. Abdel-Gawad.2001. Effect of opening roller and rotor speed in open end spinning on fiber and yarn properties of long-staple Egyptian cottons. Egypt. J. Appl. Sci.;16(4): 88-99.

6. Hancock, H. A. 1937. A spinning procedure for cotton samples.

J. Textile Inst. 28: 161-176.

7. Oxenham, W. 2002. Current and future trends in yarn production. The Textile Institute 82nd World Conference, Cairo, Egypt

8. Simpson, J., 1978. Don't throw away one-third of your cards. Textile world, August: 37-38.

9. Simpson, J., and M. A. Patureau. 1979. Effect of rotor speed on open-end spinning and yarn properties. Text. Res. J. 49: 468-473.

10. Tyagi, G. K., S. Dhamija and K.R. Salhotra. 1999. Influence of fiber length and opening roller speed on physical properties of OE rotor-spun viscose yarns. Indian J. Tex. Res. 24: (3) 21-26.

11. Vila, F., A. Pey and A., Barella. 1982. Influence of the preparation in open-end spinning of cotton. Comparative study of four processes. I. Bulletin Scientifique de l' Institut Textile de France, 11 (44): 53-63.

تحديد طريقة إختيار قياسية لتقييم الأقطان المصرية الطويلة على نظام غزل الطرف المفتوح

الجزء الأول : تأثير متغيرات التشغيل

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معهد بحوث القطن – مركز البحوث الزراعية – الجيزة

إجريت هذه الدراسه بهدف تثبيت متغيرات التشغيل وهى تأثير عدد مرات السحب وسرعة الروتر وقطر الروتر لغزل الأقطان المصرية التجارية الطويلة على ماكينة غزل الطرف المفتوح . وإستخدام لهذه الدراسة صنف القطن جيزة ٨٣ وتم غزله على نمرة ٣٠ إنجليزى ومعامل برم ٤,٢ على سرعات وأقطار روتر متغيرة وأيضاً ضفائر سحب متغيرة . ويمكن تلخيص أهم النتائج فيما يلى :

١ – يوجد تحسين معنوى ملحوظ فى متانة الشلة وعدم الإنتظامية وكذلك فى صفة عيوب الخيط فى تأثير عدد مرات السحب . وأن التحسين فى خواص الخيط كان عالياً فى حالة إستخدام ضفائر السحب الثانى بالمقارنة بضفائر السحب الأول أو بضفائر التسريح .

٢ – إستخدام قطر الروتر ٣١ مللى أعطى خيوط أعلى متانة وأكثر إنتظاماً وأقل فى العيوب أكثر من أقطار الروتر ٣٣ و ٤٠ مللى .

٣ – أفضل خواص للخيط أنتجت عند إستخدام قطر روتر ٣١ مللى عندما يدور بسرعة مائة ألف لفة / دقيقة .

٤ – عند تشغيل عينات للعمل الروتينى يستلزم إستخدام شريط السحب الثانى وإستخدام قطر الروتر ٣١ مم عندما يدور بسرعة ١٠٠,٠٠٠ لفة / دقيقة .