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CONTRIBUTION OF FIBER PROPERTIES TO YARN PROPERTIES OF SOME EGYPTIAN COTTON VARIETIES

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ABSTRACT

The present study was carried out in the Laboratories of Cotton Technology Research Division, Cotton Research Institute, Agricultural Research Center, to study the relationship between fiber properties and yarn properties and the contribution of fiber properties on yarn properties of some Egyptian cotton varieties. A bulk sample was taken from the cotton crop of 2005 season. Six Long-staple commercial cotton varieties namely, Giza 85, Giza 86, Giza 89, Giza 80, Giza 83, Giza 90 and promising cross (Giza 89 x Giza 86) were used as experimental materials. These samples were spun into a constant carded yarn count 60's at twist factor 3,6. Fiber and yarn tests were carried out under the controlled atmospheric condition of 65 % ± 2 relative humidity and 21˚C ± 2 temperature. The simple analysis of variance, correlation and stepwise statistical technique were used. The obtained results revealed that all fiber and yarn properties under study were significant affecting with the varieties under study. Strongly positive significant correlation was found between single yarn strength and fiber strength. The positive significant correlation was found between fiber elongation and Single yarn elongation. Fiber fineness contribute better than fiber strength and consequently, yarn strength. Micronaire reading appears to have the most effect of any other fiber property on yarn irregularity. The best characters affecting yarn strength in Egyptian cotton grown at upper and delta region Egyptian long staple cotton varieties were fineness and CV % irregularity, while in lea count were fineness and maturity.

Keywords: Cotton, Varieties, Fiber, Yarn, Correlation and Contribution

INTRODUCTION

The fibers are fundamental units used in making of yarns. However, it is widely accepted that fiber characteristics are highly transmissible to yarn. The matter of fact high quality yarns could be obtained from varied combinations of fiber properties. Therefore, knowledge must be obtained regarding to the contribution of each fiber property to yarn properties.

Fiber length, strength, elongation and micronaire reading (fineness and maturity) are the principal properties of cotton fiber know to be closely related to yarn properties. Fiber length is in fact, the principal determinate of yarn strength.

Fiber strength and elongation are the two essential characteristics affecting yarn strength and elongation as they are transmitted to yarn. Fiber length, fineness and maturity as well as yarn properties play their important rules through affecting the percentage of transmission of strength and elongation from fiber to the yarn, extensive research proved the strong relation between fiber elongation and yarn elongation. Elongation of fibers positively influences spindle speed and consequently, productivity. Higher fiber elongation leads directly to higher yarn elongation.

Yarn appearance: refers to the relative evenness, smoothness, and freedom from foreign material of the yarn as evaluated by a visual comparison of the yarn with standards adopted by ASTM. Appearance is important in many types of cotton products therefore high yarn appearance grades are desirable.

Neps are small tangled knots of fibers which may be a source of trouble in manufacturing yarns and fabrics. It is desirable that cotton should be relatively free of naps. In this connection Behery (1978) reported that the maturity and fineness are the most related to nap formation. Sife (1984) stated that fiber length, length uniformity, strength and maturity as well as yarn strength and appearance were positively correlated with lint grade index. He added that fiber strength and its interaction with fiber length and micronaire value were the most contributors to yarn strength appearance. More, Abdel Sttar and Hussain (1985) concluded that fiber length and strength are the most important contributors to yarn strength and evenness. Kamal *et al.* (1987) concluded that the frequently stated claim that stronger cotton fiber properties, stronger yarn and the fiber elongation exerted the greatest influence both directly and indirectly on yarn elongation. Al Mashouly and Abed (1987) using the stepwise statistical technique found that the mean fiber length and length variation explained 83% of the variation in yarn evenness. Sawires *et al.* (1989) stated that the fiber strength and fiber length exerted the greatest influence upon yarn strength and the fiber length parameters, micronaire reading and fiber elongation were the three main fiber properties contribution to yarn elongation. Steadman *et al.* (1989) reported that immature fibers are nuclei for neps. This problem, which would be more noticeable in yarn dyed fabrics, is probably the chief limiting factor in spinning fine rotor yarn from low micronaire cotton fiber. El-Hariry *et al*. (1990) found that the fiber strength was an important contributor to yarn evenness in addition to fiber length and micronaire reading in case of the Egyptian cotton varieties. Sawirs *et al*. (1990) using also the stepwise statistical technique found that the fiber length parameters were the best variables contribution to the yarn elongation variation which is strongly correlated with yarn evenness. Raoof (1995) found that the longer, more uniform the fiber length distribution, the higher fineness, maturity of the fiber stronger and more extensible the bundles of the fibers. Smith (1995) found that the micronaire reading is a contributing factor to yarn strength as well as a determinant of the spinning limit of the yarn. Finally, Abd-El Salam (1999) found that the fiber length, fineness and maturity, as well as yarn properties, play important roles through affecting the percentage of transmission of strength and elongation from the fiber to the yarn and the fiber length affects yarn strength directly and elongation indirectly. Price *et al.* (2002) found that yarn strength and micronaire value provided are assignably good estimate.

MATERIALS AND METHODS

The present study was carried out in the Laboratories of Cotton Technology Research Division, Cotton Research Institute, Agricultural Research Center, to study the contribution of fiber properties to yarn

properties of some Egyptian cotton varieties. A bulk sample was taken from the cotton crop of 2005 season. Six Long-staple commercial cotton varieties and promising cross were used as experimental materials. The cotton varieties were Giza 80, Giza 83 and Giza 90 grown at Upper Egypt, while Giza 85, Giza 86, Giza 89 and promising cross (Giza 89 x Giza 86) grown in delta. Row cotton was measured for fiber characteristics. Each cotton fiber material was spun into 60's yarn count and 3.6 twist multiplier for tests of single yarn properties. The samples of all studied cotton varieties had the same lint cotton grade, i. e Good/Fully Good. About 10 Kg of each cotton material were used as a sample for fiber and yarn tests. Fiber and yarn tests were carried out under the controlled atmospheric condition of 65 % ± 2 relative humidity and at temperature 21˚C ± 2. The following fiber and yarn properties were measured:

A- Physical and mechanical fiber properties

1. Fineness (m.tex), fiber length (UHM), Uniformity index % **,** fiber strength (g/tex), fiber elongation (%), maturity(%) and micronaire reading were measured by (H.V.I) High Volume Instrument, according to ASTM (A standard D 4065-86).
2. Fiber stiffness = (Fiber strength / Fiber elongation) x 100
3. Fiber toughness = (Fiber strength x Fiber elongation) / 2

B- Physical and mechanical yarn properties:

1. Single yarn strength (CN/ tex), single yarn elongation (%) were measured by the Statimat ME Automatic Tensile tester
2. Lea count strength product were measured by Good Brand (ASTM 1967-D1578).
3. The Evenness of yarn (thick – thin – neps - C.V%) were measured by Uster Tester Ш .The averages of the three tests were taken for final result.

This study was carried out using the completely randomized design with three replications. The L.S.D at 5% level of probability was used to differentiate between means according to Snedecor and Cochran (1981). Simple correlation coefficients were calculated to find out the correlation between fiber and yarn properties as described by Mode and Robinson (1959). The contribution percent using the stepwise statistical technique for both physical and mechanical fiber properties on physical and mechanical yarn properties were calculated according to Draper and Smith(1966) to gain more information on the relative contribution of the traits.

RESULTS AND DISCUSSION

I- Fiber and yarn properties

This investigation was concurred with the quantification of the contribution of fiber physical properties to yarn properties in some Egyptian cotton. It is well known that the mechanical properties of cotton fiber, such as strength, length, elongation, toughness, stiffness, etc, are depend on their molecular orient. Fiber physical and mechanical properties of Giza 85, Giza 86, Giza 89, Giza 80, Giza 83, Giza 90 and the promising cross (Giza 89 x Giza 86) were shown in Table (1). As a matter of fact, the study of the

properties of the fibers from which the yarns have been spun, has marked practical significant since it is well recognized that the inherent properties of cotton fibers are transmitted to yarns properties as shown in Table (2). This result is in agreement with that obtained by Abdel Sttar and Hussain (1985), Kamal *et al*. (1987) and Sawires *et al.* (1989).However, the data shown in Table (1) revealed that Giza 86 variety was superior in fiber properties (fineness (174.74m/tex), maturity (92.28%), fiber length (32.84m.m), uniformity index % (87.16 %), fiber strength (40.54g/tex) and the lowest of micronaire reading (3.98)).

Table (1): Fiber properties of some long stable cotton varieties

Varieties	Fineness m/tex	Maturity %	Mic reading	U.H.M (mm)	Uniformity %	Fiber strength (g/tex)	Fiber elongation %	Fiber stiffness (g/tex)	Fiber toughness (g/tex)
G85	141.51	89.58	4.54	30.20	86.49	38.50	7.04	547.01	1.35
G86	174.74	92.28	3.98	32.84	87.16	40.00	7.24	559.98	1.47
G89	163.34	86.18	4.02	31.79	86.90	37.90	6.68	567.34	1.26
G80	154.20	83.67	3.68	31.26	86.00	40.10	7.28	545.34	1.45
G83	156.34	88.98	4.12	29.76	83.94	34.40	7.72	511.90	1.32
G90	137.04	87.02	3.84	30.26	85.88	36.94	6.76	546.42	1.48
G86xG89	159.62	86.92	4.30	31.06	87.16	44.84	7.58	592.21	1.69
LSD at 0.05	**9.67**	**3.38**	**0.32**	**0.67**	**1.04**	**1.49**	**0.27**	**23.25**	**0.08**

Table (2): Yarn properties of some long staple cotton varieties

Varieties	yarn strength cN/ tex	yarn elongation cN/ tex	yarn stiffness cN/ tex	yarn toughness cN/ tex	Neps /120 yds	Thick places /120 yds	Thin places /120 yds	C.V %	Breaking load cN.cm	Lea count strength
G85	14.92	5.83	256.00	0.43	144	124	76	22.28	197.08	2250
G86	17.42	5..38	323.70	0.46	146	150	86	23.19	206.36	2340
G89	14.41	5.16	279.26	0.37	268	231	138	24.57	185.47	1985
G80	14.63	5.33	274.48	0.37	150	130	76	22.32	175.77	1885
G83	12.91	6.06	213.09	0.39	121	125	77	22.47	185.31	1780
G90	12.97	6.15	210.89	0.40	183	171	148	24.49	241.78	1700
G86xG89	18.37	5.00	367.40	0.46	351	310	91	19.58	256.95	1970
LSD at 0.05	**0.80**	**0.97**	**27.76**	**0.04**	**33.58**	**20.38**	**22.93**	**0.48**	**15.54**	**53.78**

The promising cross (Giza 86 x Giza 89) was superior in uniformity % (86.92%), fiber strength (44.84 g/tex), fiber stiffness (592.21 g/tex) and fiber toughness (1.69g/tex).

The data show in Table (2) revealed that Giza 86 variety was superior in single yarn strength (17.42 cN/tex), yarn stiffness (323.70 cN/tex), yarn toughness (0.46 cN/tex) and lea count strength (2340) than other varieties.

The promising cross (G89xG86) was superior in single yarn strength (18.37 cN/tex), yarn stiffness (367.40cN/tex), neps (351/120yds), thick places (310/120 yds), breaking load (256.95 cN.cm) and the lowest of C.V % (19.58 %) than other varieties. This result is in agreement with Kamal *et al.* (1987), Sawiers *et al* (1990) and Abd-EL Salam (1999).

Table (1) showed that Giza 86 superior in fineness (174.74 m/tex), maturity (92.28 %), fiber strength (40.54 g/tex), fiber elongation (7.24 %) and the lowest in micronaire reading (3.98). This result affects of yarn

properties (high single yarn strength (17.42 cN/tex), lea count strength (2340). The promising cross (Giza 89 x Giza 86) gave the highest fiber strength (44.84 g/tex) that exerted the greatest influence on single yarn properties (18.37 cN/tex), this result is in agreement with Kamal *et al.* (1987), Sawiers *et al.* (1990) and Abd-EL Salam (1999).

II-Simple correlation between fiber properties and yarn properties to long staple cotton varieties

Data in Table (3) show that the correlation between fiber properties (Fineness, maturity %, micronaire reading, fiber length, fiber strength, fiber elongation %, fiber stiffness and fiber toughness) and yarn properties , i.e. yarn strength, yarn elongation %, yarn stiffness, yarn toughness , C.V% and lea count strength.

Table(3): Simple correlation between fiber properties and yarn properties to long staple cotton varieties

Characters	Yarn strength c.N/tex	Yarn elongation %	Yarn stiffness cN/tex	Yarn toughness cN/tex	C.V%	Lea count strength
Fineness m.texs	0.581	-0.565	0.682	0.323	-0.121	0.459
Maturity %	0.225	0.317	-0.380	0.733*	0.089	0.586
Micronaire reading	0.295	0.017	0.067	0.480	-0.458	0.455
Fiber length U.H.M	0.618	-0.696*	0.698*	0.280	0.127	0.587
Fiber strength g/tex	0.912**	-0.787*	0.916**	0.527	-0.676*	0.378
Fiber elongation %	0.833**	0.534*	0.795*	0.520	-0.623*	0.367
Fiber stiffness g/tex	0.789*	-0.082	0.832**	0.350	-0.374	0.315
Fiber toughness g/tex	0.869**	-0.666	0.857**	0.577	-0.703*	0.245

***, ** significant at 0.05 and 0.01level of probability, respectively.**

Data in table (3) revealed that the positive significant correlation was found between single yarn strength (cN/tex) and fiber stiffness (g/tex). Moreover, strongly positive significant correlations were found between single yarn strength (cN/tex) and fiber strength (g/tex), fiber elongation % and fiber toughness (g/tex). On the other hand, single yarn elongation recorded negative significant correlation with fiber length and fiber strength. The positive significant correlations were found between fiber elongation and Single yarn elongation. The strongly positive significant correlations were found between yarn stiffness with fiber strength, Fiber stiffness and Fiber toughness. Yarn toughness revealed positive significant correlation with maturity%. Negative significant correlation was found between C.V% and each of fiber strength, fiber elongation and fiber toughness. These results are in general agreement with these obtained by Raoof (1995) and Abd-El Salam (1999).

III- Contribution of fiber properties to yarn properties of some Egyptian cotton varieties

The best equation of contribution and prediction equations of cotton fiber quality to yarn quality of Upper Egypt long staple cotton varieties and Delta region Egypt long staple cotton varieties were estimating with stepwise statistical technique and showed in Tables (4 and 5)

Y1=18.0042+0.2562X4+(-0.02570) X2+(-3.47414)X8 +(– 0.26491) X12	0.8601	(Y1)Yarn strength, (X4) Fiber strength,(X2) Fineness, (X8)No of reversals, (X12) CV%
Y2 = 14.4625 + (-0.1621)X5+ (-9.6608) X9	0.9310	(Y2)Yarn elongation, (X5) Fiber elongation, (X9) Elongation due unfolding convolutions
Y3 = - 1245.52 + 73.7944 X1+ 2.91700 X2 + 4.0831 X3	0.6100	(Y3) Lea count product, (X1)Fiber length, (X2) Fineness,(X3)Maturity
Y4 = 14.5514 + 0.02557 X13 + 0.0115 X14 + 0.04331 X3	0.9525	(Y4) CV%, (X13) No of thick places, (X14) NO of thin places, (X3) Maturity
Y5 = - 349.3535 + 19.3436 X10 + 26.5022 X11+ (- 6.3007) X4 + 314.5573 X8	0.8027	(Y5) Breaking load, (X10) Yarn strength, (X11)Yarn elongation, (X4) Fiber strength, (X8) No of reversals

Table (4): The best equation of contribution and prediction equations of cotton fiber quality to yarn quality of Upper Egypt long staple cotton varieties

The results of this analysis could be summarized as shown in Table (4) The best equation effective four variables affecting yarn strength (Y1) were fiber strength, fineness and no of reversals, CV% irregularity (R^2=0.8601).

The best equation effective two variables affecting yarn elongation (Y2) were fiber elongation and elongation due unfolding convolutions (R^2=0.9310).

The best equation effective five variables effecting lea count product (Y3) were fiber length, fineness and maturity (R^2=0.6100).

The best equation effective three variables effecting CV% irregularity (Y4) were number of Thick places, number of thin places and maturity (R^2=0.9525).

The best equation effective four variables effecting breaking load (Y5) were yarn strength, yarn elongation, fiber strength, number of reversals (R^2=0.8027).

The results of this analysis could be summarized as shown in Table (5) The best equation effective four variables affecting yarn strength (Y1) were fiber length, fineness, maturity and CV% irregularity (R^2 = 0.8872).

The best equation effective four variables affecting yarn elongation (Y2) were fiber elongation, number of convolutions, elongation due unfolding convolutions and ribbon width (R^2 = 0.7444).

The best equation effective three variables affecting lea count product (Y3) were fiber strength, fineness and maturity (R^2 = 0.7082).

The best equation effective three variables affecting CV% irregularity (Y4) were number of thick places, number of thin places and fiber length (R^2 = 0.8222).

The best equation effective four variables affecting breaking load (Y5) were yarn strength, yarn elongation, fiber strength and no of reversals (R^2 = 0.90514).

The result shown in tables 4 and 5 the best characters affecting yarn strength in Egyptian cotton grown at Upper and Delta region of Egyptian Long Staple cotton varieties were fineness and CV% irregularity. The best characters affecting lea count product in Egyptian cotton grown upper and delta region Egyptian long staple cotton varieties were fineness and maturity. This result is in full agreement of Sife (1984).

Table (5): The best equation of contribution and prediction equations of cotton fiber quality to yarn quality of Delta region Egypt long staple cotton varieties:

The Best Equation	R^2	
Y1 = 15.08987 + (- 0.5157) X1 + 0.1220 X 2 + 0.17226 X3 + (- 0.77497) X12	0.8872	(Y1) Yarn strength, (X1) Fiber length, (X2) Fineness, (X3) Maturity, (X12) CV%
Y2 = 416.24151 + (- 1.9886) X4 + (- 8.59548) X7 + (- 446.395) X9 + (-1.84109)X6	0.7444	(Y2)Yarn elongation, (X5) Fiber elongation, (X7) No of convolutions, (X9) Elongation due unfolding convolutions, (X6) Ribbon width
Y3 = - 1526.1496 + (- 10.3563) X+(-0.5641)X2+ 47.0094 X3	0.7082	(Y3) Lea count product,(X4) Fiber strength, (X2) Fineness, (X3) Maturity
Y4 = 10.97933 + (- 0.01522) X13 +0.0419 X14 + 0.33795 X1	0.8222	(Y4) CV%, (X13) NO of thick places, (X14) NO of thin places, (X1) Fiber length
Y5 = 183.707 + 2.6556 X 10 + (- 15.425) X11 + 3.2890 X11 + (-57.8112) X8	0.9051	(Y5) Breaking load, (X10) Yarn strength, (X11) Yarn elongation, (X4) Fiber strength, (X8) No of reversals

REFERENCES

A. S. T. M. (1986). American Society for Testing and Materials. D-4605., Vol. 07, No 1, Easton, MD, USA.

Abd El Salam, M. E (1999). The Egyptian cotton production quality and marking l Kalma press. Box No.16/05/99.

Abdel Sttar, C. and Hussain, A. (1985). Combined effect of micronaire and Pressly strength characteristics on spinning performance in Pakistan Cotton. The Pakistan Cotton,39 (3):117-126.

Behery, H. M. (1978). Neps in cotton processing. (Paper presented at the textile quality control, association, fall meeting). September, 14-15.

Draper, N.R and Smith, H. (1966). Applied regression analysis john Willy and Sons Inc. , New York.407 pp.

El-Hariry, S. H. M; F. S. Mansour; E. M. S. Sawires and M. G. Seif (1990).The relative contribution of fiber properties to yarn Physical Properties of Egyptian cotton variety by using Stepwise regression analysis. Agric. Res. Rev, 68 (6):1282-1297.

Kamal, M. M; M. A. Mahgoub and Nafisa, T. Ahmed (1987). Fiber physical properties in relation to yarn mechanical properties in Egypt, Annals Agric. Sci., Fac. of Agric., Ain Shams Univ., Cairo Egypt. 32 (2):1138-1148.

Mode, G. J. and H. F. Robinson (1959). Pliotropism and genetic variance and covariance . Biometrics 15: 518-537.

Price, J. B.; X. Cui; T. A. Calamari and JR, W. R. Meredith (2002). Cotton wax and Its relationship with fiber and yarn properties. Textile Research J., 2 (7):631-637.

Raoof, M. A. (1995). Studies on some technological properties of new Egyptian Cotton varieties. Ph. D. Thesis, Department of Agronomy and Agric, Engineering Faculty of Agric, Moshtohor, Zagazig University.

Sawires, E. M. S; M. G. Sief; S. H.M. El-Hariry and F. S. Mansour (1989). Effect of cotton cultivars, locations and their interaction on the relative contribution of fiber properties to yarn strength. Agric. Res. Rev., 67(5):813- 824.

Sawires, E. M. S.; Seif, M. G.; EL-Hariry, S. H. M. and F. S. Mansour (1990). The relative Contribution of fiber properties to yarn mechanical properties in Giza 86 cotton variety by using Stepwise regression analysis. Agric, Res. Rev., 68 (6):1229-1308.

Sief, M. G. (1984). Spinning performance as affected by yarn counts, twist factor and fiber properties in some Egyptian, cotton varieties. Ph. D. Thesis, Fac. of Agric., Ain - Shams Univ., Egypt.

Smith, H. R. (1995). Quality makes a difference. How fiber properties affect processing. Proceedings Belt wide Cotton Conferences Cotton Txtile, Processing Conf., 1402-1403.

Snedecor, G. W. and Cochron, W. G. (1981). Statical Methods 7 ed., lowa stste Univ. Press. Ames, Lowa.

Steadman, R. G.; J. R. Gipson; R. D. Method and A. S. Soliman (1989). Factors affecting rotor spinning of fine cotton yarn. Text. Res. J., 24 (59): 371-382.

مدى مساهمة صفات التيلة في صفات الغزل لبعض أصناف القطن المصري

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أجريت هذه الدراسة بمعامل بحوث تكنولوجيا القطن التابعة لمعهد بحوث القطن مركز البحوث الزراعية بالجيزة بهدف دراسة العلاقة بين صفات التيلة وصفات الغزل للخيط المغزول منها وأيضآ مدى مساهمة صفات التيلة فى صفات الغزل وأستخدم لهذه الدراسة ستة أصناف من القطن المصرى طويل التيلة هى جيزة ٨٥، جيزة ٨٦، جيزة ٨٩ ، جيزة ٨٠، جيزة ٨٣ ، جيزة ٩٠ والهجين المبشر(جيزة ٨٦ x جيزة ٨٩) وتم غزل العينات على نمرة ٦٠ بمعامل برم ٣,٦ وأجريت الأختبارات بالطرق القياسية التابعة لـ ASTM (American Society for Testing and Material) وتحت جو قياسي على طول فترة الأختبارات (رطوبة نسبية ٦٥ ± ٢% ودرجة حرارة ٢١ ± ٢°) على عينات محصول ٢٠٠٥. تم تحليل البيانات باستخدام التباين والارتباط البسيط والانحدار المتعدد المراحل لدراسة مدى مساهمة صفات التيلة فى صفات الخيط المغزول منها وقد أشارت النتائج إلى أن هناك علاقة طردية موجبة وقوية بين متانة واستطالة التيلة ومتانة واستطالة الخيط المغزول منها وتساهم نعومة الألياف فى متانة الخيط لأرتباطها بعدد الشعيرات فى المقطع العرضى للخيط وكذلك تؤثر قراءة الميكرونير تأثير كبير فى خواص الألياف ومن ثم فى خواص الخيط فى مظهريتها وانتظامها. وعموما كان أفضل الصفات لأصناف القطن المصرية للدلتا والوجه القبلي التي تساهم في متانة الغزل هي النعومة والانتظامية وكذلك أهم الصفات التي تساهم في متانة الشلة كانت النعومة والنضج .