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RESPONSE OF YARN STRENGTH AND REGULARITY TO TWIST IN LONG STAPLE EGYPTIAN COTTON VARIETIES

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ABSTRACT

The newly introduced long staple cotton varieties Giza 89 and Giza 90 and the relatively older Giza 83 were spun at 30s, 40s, 50s and 60s counts , as well as , each count twisted on 3.4, 3.8, 4.2 and 4.6 twist factors to study the response of lea strength and regularity to the increasing of twist. The first degree regression models of linear, logarithmic and power were applied to define the relation between lea strength and twist factors for every individual planned count . The test of significant was according to coefficient of correlation (r) . In conformity with the insigniificant relations in derived equations of the above regressions ,the second degree polynomial regression was practiced and derived equations achieved significaut relations.The results showed that lea strength increases on the act of adding twist beyond to 4.2 twist factor and then reduced at 4.6 twist factor within the same count . The optimum twist factor was 4.2 for all spun yarns . Equations which were derived on the basis of the statistical polynomial regression could be applied with considerable accuracy on Giza 83 , Giza 89 and Giza 90 spun yarns at the examined twist factors. Yarn regularity was not significantly affected by increasing twist factor within any one count.

INTRODUCTION

It has long been known that a strand of cotton fibers at zero -twist has no strength , because the fibers slide over one another when they were put under tension .However increasing twist would increase resistance to slippage . Yarn strength attains maximum value at optimum twist and in back of that peak it tends to decline progressively.

One practical difficulty which confuses the interpretation of experimental results is the great irregularity of spun yarns .The yarns vary greatly in linear density, and in arrangement of fibers and hence in twist along their length, consequently they vary in mechanical properties.

The need to interpret the course of action of the two major spinning variables yarn twist and count, and theirs association, which predominante the yarn performance, was the foremost objective of this study by applying special mathematical relationships to evaluate these effects, and weighting statistically its significance.

Debarr Morton (1931) and Catting (1965) and showed that the function of twist is to produce cohesion between fibers together. When the yarn is put under tension the fibers slip or break depending on the angle of twist . If the angle of twist is small, very few fibers are broken when the yarn ruptures (due mainly to fiber slippage) and small portion of the potential strength is utilized. As the twist angle is increased more fibers are utilized to favour yarn strength until fiber slippage is completely eliminated from all parts of the yarn. Any further increase in yarn twist causes a reduction in yarn strength due to the effect of obliquity. Gregory (1950) stated that breaking length increased slowly at first with the increase of twist and then more rapidly, and finally declined at very high twist. The optimum strength could be achieved at the balance between cohesion of fibers, which increases the yarn strength and the inclination of individual fibers relative to yarn axis which decreases yarn strength. Louis *et al.* (1961) reported that yarn made from coarse fibers required more twist to attain maximum strength than that made from fine fibers at the same count. Nanjundayayya (1966) postulated that evenness of yarn thickness was very important because yarn broke at the thinnest place of the test length. He found that the twist angle at place of break was high indicating that at the place of rupture the specimen was over twisted. Hearile *et al.* (1969) reported that the knowledge of spun yarn mechanics is still limited, and this is partly due to the fact that, until there has been no satisfactory theoretical basis to build practical understanding. Abd-El-Salam *et al*. (1972) showed that the optimum twist factor for long and fine fibers is lower than short and coarse ones. They added that the optimum amount of twist for maximum strength depends on the balance between the degree of alignment of fibers in the yarn with respect to its long axis and cohesion force binding the fibers rather than depending on yarn evenness. Zaher *et.al.* (1975) Concluded that evenness, number of thin and thick places as well as neps not influenced by twist multiplier. Mansour (1984) found that within each count single yarn strength registered was low at lower twists, then increased at medium inserted twist and finally declined at high twit factor. It was, also reported that the optimum twist factor was 4.4 for Dendera and Giza 66. Nomeir *et al*. (1985) stated that in most cases the rate of increase in yarn strength was higher at the intermediate twist factors than that at higher ones. Salhotra and Bulasubramanian (1986) found that the maximum length of fiber which breaks during the tensile failure of yarns is dependent on yarn twist, and the minimum length lies between 6and 8 mm for ring spinning Kamal *et al*. (1988) found that when twist multiplier was held constant the coarser yarns was stronger than finer yarns. Abd-EL-Aliem (1995) concluded that at constant twist factor , yarn strength decreased if the count increased.

MATERIALS AND METHODS

The newly introduced long staple varieties, Giza 89andGiza 90 and the relatively older one Giza 83 of 1999 crop were provided by CRI,ARC .The standard 60 grams microspinning technique which is used in Spinning Research Section ,CRI,ARC was followed under controlled atmospheric conditions of 20° C ± 2°C temperature and 65% ± 2% relative humidity. The constructed carded yarns having altered counts of 30s, 40s ,50s and 60s were processed using 3.4 ,3.8 ,4.2 and 4.6 twist factors for each of the previously mentioned count .

The studied characters of spun yarns were:

1. Lea strength ,fourty- eight leas from each sample were tested on the Good Brand Lea Testr according to (ASTM 1967,D 1578)

2. Unevenness, expressed in term of CV%, was assessed by the Uster Evenness Tester 3.

Statistical analysis and graphics of the studied lea strength for different yarn counts and twists of the previous varieties were carried out on computer by using Microsoft Excel Program. The first degree regression models of linear regression, logarithmic regression and power regression were applied to investigate the relation between lea strength and twist factor within every individual planned count to select the appropriate equation . Depending upon the results of applying the above regression models the second degree polynomial regression model was applied . The test of significance was according to the coefficient of of correlation (r) , which is square root of coefficient of determination R^2 (Snedecor and Cochran 1986) . Unevenness (cv%) analysis of variance (ANOVA) was used to find out the effect of increasing twist factor on yarn regularity following (SAS 1985) statistical program of the Computer .

RESULTS AND DISCUSSION

Table 1: Lea strength means of the studied counts and twist factors in each of Giza 83,Giza 89 and Giza 90

Varieties	Count/twist	3.4	3.8	4.2	4.6
	30s	2490.4	2590.8	2636.6	2545
Giza 83	40s	2362.5	2438.3	2522.9	2477.5
	50s	2128.7	2244.1	2330.8	2201.2
	60s	2003.7	2115.0	2165.0	2047.0
	30s	2650.0	2738.3	2779.5	2706.2
Giza 89	40s	2422.9	2589.1	2657.2	2527.9
	50s	2289.5	2392.9	2459.5	2347.9
	60s	2165.4	2253.3	2291.6	2194.1
	30s	2440.4	2540.8	2590.8	2502.7
Giza 90	40s	2312.5	2388.3	2472.9	2427.5
	50s	2078.7	2194.1	2280.8	2151.2
	60s	1953.7	2065.0	2115.0	1997.0

**** Each mean was calculated from 48 measurements.**

The results in the above table display the following trends:

The lea strength was reduced on what occasion the count increased in all varieties at the same twist factor. This is due to the decrease in fibers denisty by increasing count, Kamal *et al*. (1988) found that when twist multiplier was held constant the coarser yarns were stronger than finer yarns . The same results were obtained by Abd-El-Aliem (1995)

Lea strength increased in the act of adding twist up to 4.2 twist factor and the it reduced at 4.6 twist factor for the same count. This effect of twist was explained by Hearil *et al* (1969) as being ascribed to a combination of reducing slippage and increasing breakage of fiber , and concluded that this would increase resistance to slippage, and hence decrease the proportion of fibers which slip rather than break gradually ,as well as ,fibers gripping due to increasing of twist . De Barr and Morton (1931) Catting (1965) and explained the function of twist and reported that,If the angle of twist is small ,very few fibers are broken when the yarn ruptures (due mainly to fiber slippage)and small portion of the available strength is utilized . As the twist angle is increased yarn strength increases, since more and more fibers are utilized until fiber slippage is eliminated completely from all parts of the yarn . Any further increase in yarn twist causes a reduction in yarn strength due to the effect of obliquity. Gregory (1950), Abd-El-Salam *et al.* (1972) , Mansour (1984) , Nomeir *et al*. (1985) and Salhotra and Bulasubramanian (1986) reported the same trend in direct observation and results .

The optimum twist factor for any count of the considered varieties was found to be 4.2. The above mentioned researchers were in agree about the effect of increasing twist on yarn strength and detected that maximum yarn strength was attained on the optimum twist .

Giza 89 yarns for any given count and twist factor accomplished higher strength than those of Giza 83 orGiza 90.

The above results were illustrated graphically and statistically analized for each variety to conceive how to deal with the companionship of twist and count on lea strength.

Figure (1), Figure (2) and Figure(3) show the derived equations of

A. Linear regression
B. Logarithmic regression
C. Power regression
D. Polynomial regression

found for Giza 83,Giza 89 and Giza 90 spun yarns , respectively. Snedecor and Cochran (1986) reported that the greater R^2 value represent higher contribution to the dependent variable, and it's maximum value = 1 which is achieved in case of intimately related characters.

A-Linear regression R^2 values in Table(2) show low contribution to the variation in yarn strength for every derived regression equations for all yarns , and these equations achevied insignificant level of (r) between lea strength and twist factor .Therefore they are not appropriate to apply in such cases. Also B- logarithmic regression R^2 values and C- power regression R^2 values in Table (2) presented low contribution to the variation in yarn strength for every derived regression equations and insignificant (r) values. Alsothese equations are not suitable to use in similar matter .It is possible to recognize immediately in Table(2) that R^2 of D-polynomial regression equations are approximately alike and utilize high contribution to the variation in yarn strength in all yarns and significance (r) between lea strength and twist factor for every derived regression equations in the considering counts .With respect to R^2 values it is apparent that statistical polynomial regression analysis is practicable than the others as show in Table (2) . Consequently statistical polynomial regression could be applied with considerable accuracy on Giza 83 , Giza 89 and Giza 90 spun yarns at the investigated twist factors

Polynomial regression equations of studied varieties and counts at determined twist factors, at which place (y) denotes to lea strength and (x) denotes to twist factor.

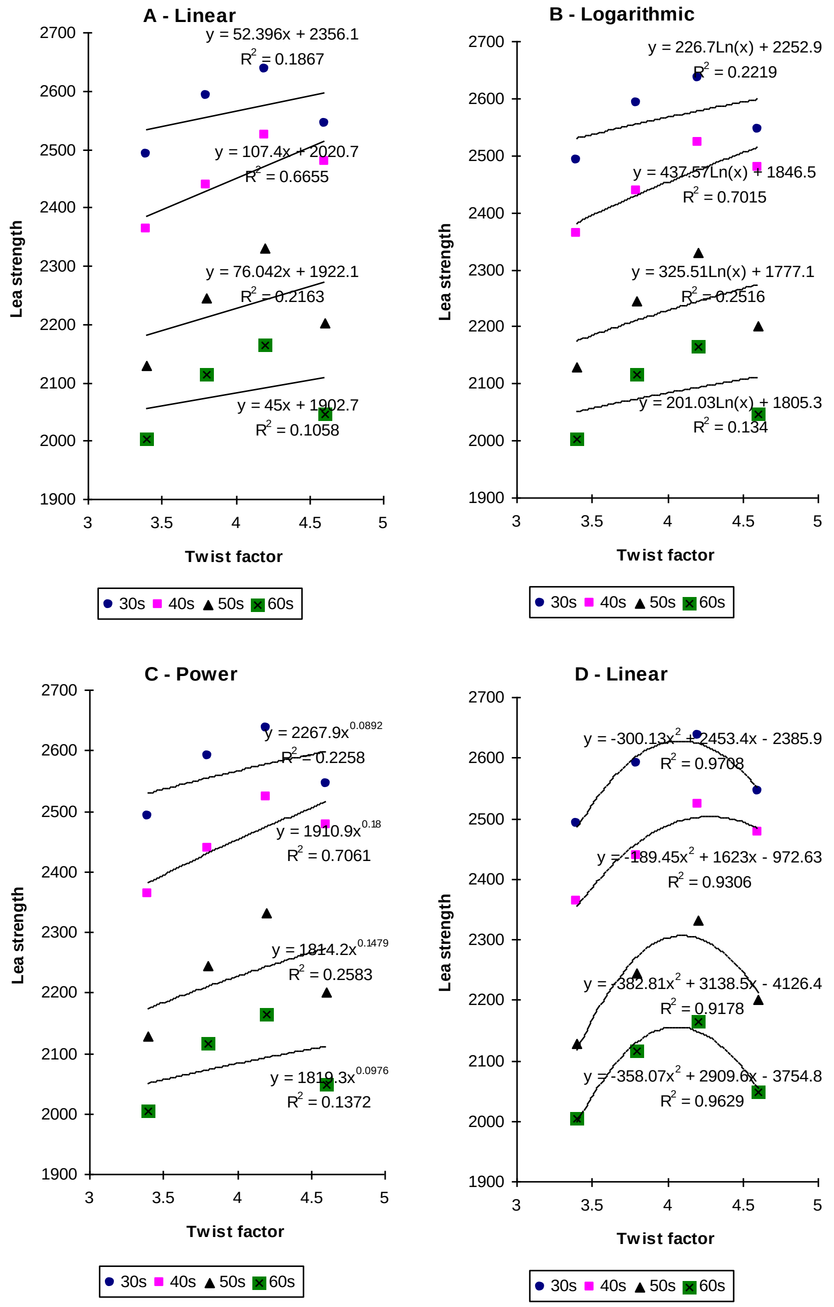

Figure (1): Regression lines and derived equations of the relation between lea strength and twist factor in 30s ,40s ,50 and 60s counts of Giza 89 spun yarns

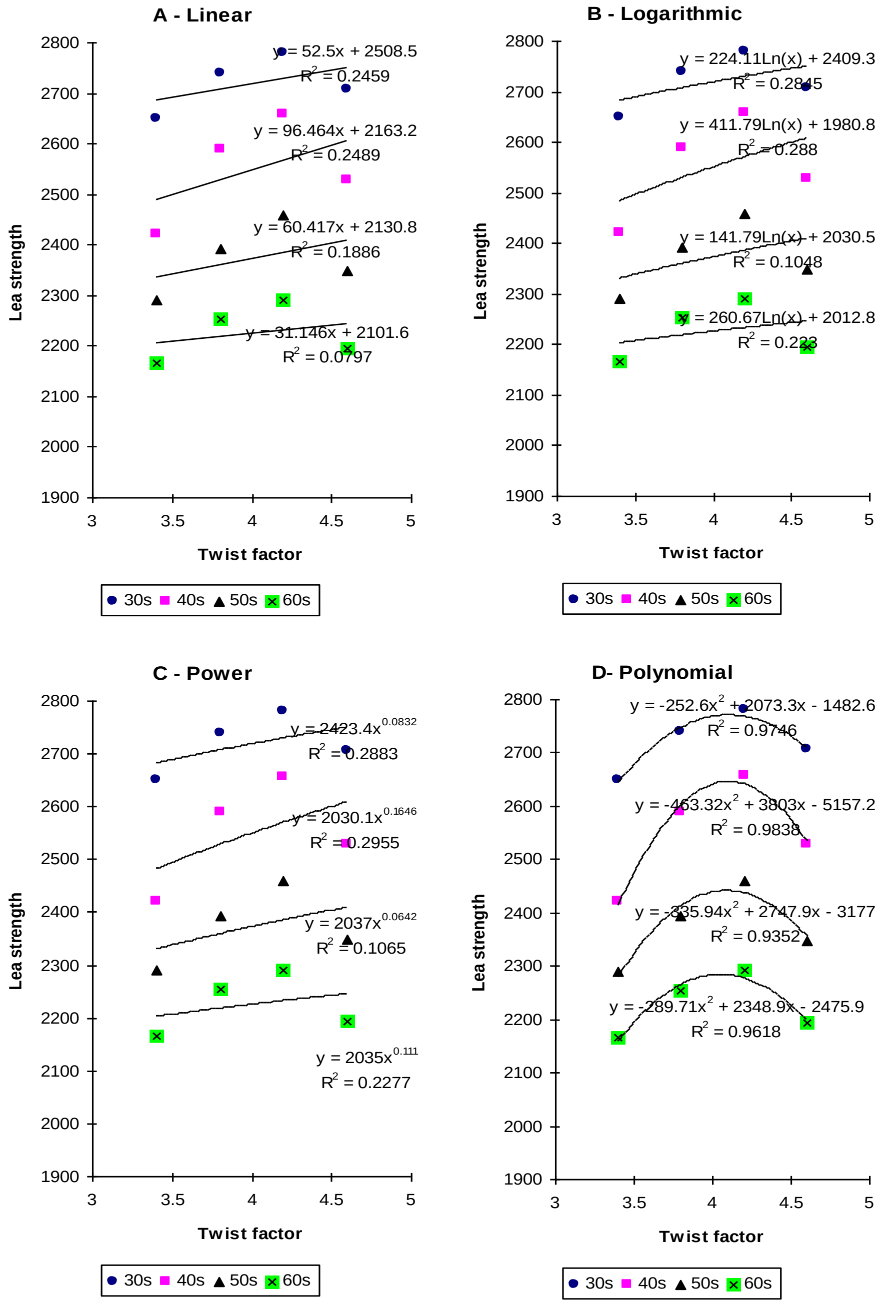

Figure (2):Regression lines and derived equations of the relation between lea strength and twist factor in 30s ,40s ,50 and 60s counts of Giza 83 spun yarns

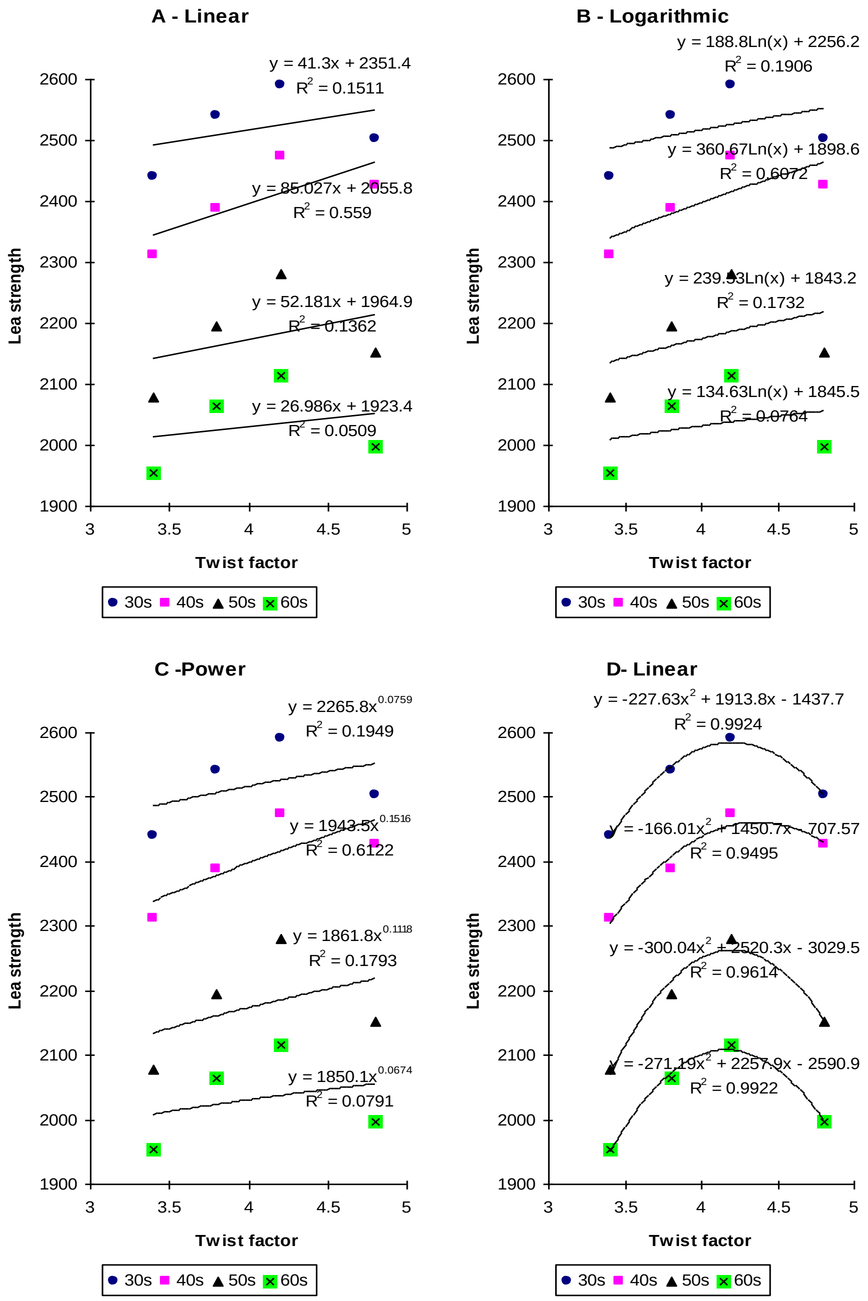

Figure (3):Regression lines and derived equations of the relation between lea strength and twist factor in 30s ,40s ,50 and 60s counts of Giza 90 spun yarns

Table 2: R^2 and r values for derived regression equations of Giza 83 , Giza 89 and Giza 90 yarn counts at considered twist factors

Varieties	Count	A-Linear		B-Logarithmic		C-Power		D-Polynomial	
		R^2	r	R^2	r	R^2	r	R^2	r
	30s	0.1867	0.43	0.2219	0.47	0.2258	0.47	0.9708	0.98
Giza 83	40s	0.6655	0.81	0.7015	0.83	0.7061	0.84	0.9306	0.96
	50s	0.2163	0.46	0.2516	0.50	0.2583	0.50	0.9178	0.95
	60s	0.1058	0.32	0.143	0.36	0.1372	0.37	0.9629	0.98
	30s	0.2459	0.49	0.2845	0.53	0.2885	0.53	0.9746	0.98
Giza 89	40s	0.2489	0.50	0.2880	0.53	0.2955	0.54	0.9838	0.99
	50s	0.1886	0.43	0.1048	0.32	0.1065	0.32	0.9352	0.96
	60s	0.0797	0.28	0.2230	0.47	0.2277	0.47	0.9618	0.98
	30s	0.1511	0.38	0.1906	0.43	0.1949	0.44	0.9924	0.99
GIZA 90	40s	0.5599	0.74	0.6072	0.77	0.6122	0.78	0.9495	0.97
	50s	0.1362	0.36	0.1732	0.41	0.1793	0.42	0.9614	0.98
	60s	0.0504	0.22	0.0784	0.28	0.0791	0.28	0.9922	0.99

Coefficient of correlation r at probability level 0.05 = 0.95

Giza 83

(30s) $y = -300.13 x^2 + 2453.4x - 2385.9$

(40s) $y = -189.45 x^2 + 1623x - 972.63$

(50s) $y = -382.81 x^2 + 3138.5x - 4126.4$

(60s) $y = -358.07 x^2 + 2909.6x - 3754.8$

Giza 89

(30s) $y = -252.6 x^2 + 2073.3x - 1482.6$

(40s) $y = -463.32 x^2 + 3803x - 5157.2$

(50s) $y = -335.94 x^2 + 2747.9x - 3177.$

(60s) $y = -289.71 x^2 + 2348.9x - 2475.9$

Giza 90

(30s) $y = -227.63 x^2 x^2 + 1913.8x - 1437.7$

(40s) $y = -166.01 x^2 + 1450.7x - 707.57$

(50s) $y = -300.04 x^2 + 2520.3x - 3029.5$

(60s) $y = -271.19 x^2 + 2257.9x - 2590.9$

In order to make a forecast of yarn strength , the twist factor value can be used in any of the preceding equations.

The increasing of twist factor as shown in Table (3) has insignificant effects within each count . Significant effects were detected when increasing count within each variety .Also insignificant differences were achieved between the varieties spun yarns of the concerned varieties at the same count and twist factor.

G90 spun yarns were more regular at the same count and twist factor than those of G89 and G83, yet these differences were insignificant, Zaher *et al*. (1975) found the same results .

Table 3:Unevenness (CV%) of G83 ,G89 and G90 spun yarns of different counts and twist factors

Varieties	Count	Twist factor			
		3.4	3.8	4.2	4.6
G83	30s	16.5	16.18	16.63	16.01
G89		15.55	15.87	15.56	15.86
G90		15.02	15.11	14.98	15.12
G83	40s	18.56	18.57	18.48	18.73
G89		18.22	18.24	18.09	18.55
G90		17.98	17.88	17.67	17.54
G83	50s	21.01	21.45	21.56	21.46
G89		20..89	20.86	20.76	20.87
G90		20.11	20.15	20.01	19.89
G83	60s	22.12	22.31	21.89	22.15
G89		21.35	22.01	21.15	21.85
G90		21.18	21.54	20.85	21.44

(Least significant differance at 0.05 significant level) L .S.D =1.3

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استجابه متانـه و انتظـام خيـوط الغزل للبـرم فـى اصـناف طويلـه التيلـه مـن القطـن المصري

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يلعب البرم دورا اساسيا فى متانه خيوط الغزل . و تتوقف كميه البرم اللازمـه علـى الغرض من استخدام الغزل.وقد اجريت هذه الدراسـه علـى صـنفين جديـدين مـن الاصـناف الطويلـه جيزه 89 ،جيزة 90 بالاضافه الى صنف القطن الطويل الاقدم نسبيا جيزة 83 وذللك لمعرفـه تـاثير زيـاده البـرم داخل النمر تحت الدراسـه علـى متانـه الخيوط وكذلك الانتظـام . ولمعرفـه العلاقـه بـين معامـل البـرم ومتانـه الخيوط تم اختبـار معنويه معادلات وخطوط انحدار مختلفه لاختيار العلاقه المعنويه التـى يمكن استخدامها للتنبؤ بمتانـه الخيوط بدلالـه معامـل البـرم .وقـد اجريـت الدراسـه علـى النمـر الانجليزيـه 30ت و40ت و50ت و60ت وكانـت معاملات البرم لكل نمره 3.4و3.8و4.2و4.6 . وكذلك تـم اختبـار انتظـام خيـوط الغـزل علـى كل مـن النمـر ومعاملات البرم.وكانت النتائج كما يلى:

1. تزداد متانه خيوط الغزل داخل الاصناف المختبره على النمر المختبره بزياده معامل البرم حتى 4.2 ثم تنخفض المتانه على معامل البرم 4.6
2. يعتبر معامل البرم 4.2 الامثل لكل الاصناف والنمر
3. لم تظهر معادلات الانحدار من الدرجه الاولى (الخطيه واللوغاريتميه والقوة) علاقه معنويـه بين النمـره ومعامل البرم
4. أظهرت معادلات الانحدار الخطيه من الدرجـه الثانيـه علاقـه عاليـه المعنويـه بـين النمـره ومعامـل البـرم داخل الاصناف المختبره
5. لم يتاثر انتظام خيوط الغزل معنويا على معاملات البرم المختبره داخل النمره الواحده بزياده البرم
6. تـاثر انتظـام خيـوط الغـزل بمستويات معنويـه مختلفـه بزيـاده النمـره علـى معـاملات البـرم المختبـره لكـل الاصناف
7. حققـت خيـوط الصـنف جيـزه 90 انتظامـا أعلـى مـن الاصـناف جيـزة 89 وجيـزة 83 وان كانـت الاختلافات غير معنويه على جميع النمر ومعاملات البرم.