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RELATIONSHIP BETWEEN FIBER COTTON GRADE AND SOME RELATED CHARACTERISTICS OF LONG AND EXTRA-LONG STAPLE EGYPTIAN COTTON VARIETIES (*Gossypium barbadense*. L)

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ABSTRACT

The materials used in this study were four commercial varieties of Egyptian cotton; two (Giza 86 and Giza 90) belonging to the long staple class and the others (Giza 88 and Giza 92) belonging to the extra-long staple category. Within each variety, nine lint cotton grades namely: Fully Good (FG), Good/Fully Good (G/FG), Good (G), Fully Good Fair/Good (FGF/G), Fully Good Fair (FGF), Good Fair/ Fully Good Fair (GF/FGF), Good Fair (GF), Fully Fair/Good Fair (FF/GF) and Fully Fair (FF) were used. Thus Fully Good (FG) is the top quality grade and the others are progressively lower; i.e. Fully Fair (FF) is the lowest grade. Fiber properties were measured by using the Cotton Classifying System Version-5 instrument (CCS-V5). Data collected for the following characteristics were: reflectance degree (Rd %), yellowness degree (+b), trash%, dust%, fiber fragments%, total trash%, No. of neps and Micronaire value.

Mean squares due to all nine grades of long and extra-long staple cotton varieties in combined analysis were highly significant over seasons for all studied characters except yellowness (+b) and fiber fragments% in Giza 92. Highly significant mean performance values of four cotton varieties and nine lint grades for each variety for all studied characters, it became clear that there were significant genetically differences between studied varieties and fiber cotton lint grades within each variety. Gradually increased for yellowness degree, trash%, dust%, fiber fragments%, total trash% (trash, dust, fiber fragments) and number of neps, while gradually decreased for reflectance degree (Rd%) and micronaire value with significant level as transfer for all tested varieties from (FG) grade down to the (FF). All studied varieties showed highly significant negative correlation between fiber cotton grade with yellowness, trash, dust, total trash% and No. of neps, while highly significant positive correlation between fiber cotton grade with reflectance degree and micronaire value. Total trash% and micronaire value as well as reflectance degree and their interactions were the most contributing and influencing of fiber cotton grades. Also these properties and their joint effects are prevailing factors which affect the personal judgment of the grader at evaluating the cotton grade.

Keywords: Cotton grade**,** Long staple, Extra-long staple, Performance and Correlation

INTRODUCTION

Cotton crop is the first important fiber crop worldwide because it provides the raw material to the entire textile industry (**Abd El-Mohsen and Amein 2016**). The Egyptian cotton "*Gossypium barbadense* L." is a peculiar type of cotton that is characterized by softness, strength, superior characteristics, high quality, and gained a worldwide reputation for more than a century and half as being of the highest lint quality among world cottons **(Abdel-Salam et al 2009)**.

From many years, merchants, classers and spinners, in different countries, have made their selections on the basis of the official cotton standers for staple length and grade supplemented by characters, but in U.S.A., staple length is not considered in the system of classification, since it is determined primarily by the variety. All Egyptian cottons are bought first according to variety and then according to the classified grade. Grade is a composite rating determined by color, the amount of foreign matter ((i.e., trash)) and micronaire in the sample and ginning preparation. "Preparation" refers to whether fiber is damaged or tangled in the processes of ginning and "Character" is a complex attribute which is composed of these elements not included in grade, such as fiber fineness, maturity, strength, uniformity, etc. However, in cotton classing, the determination of characters, as well as grade is entirely a personal judgment.

Grading of cotton is a very intricate and complex subject, as it depends upon human perceptions of sight and touch and requires a high degree of precision and power of critical judgment on the part of the grades of a set of samples belonging to a variety.

Correlation coefficient analysis measures the magnitude of relationship between fiber cotton grade and its related characters and determines the component characters on which selection can be based for improvement of fiber cotton grade quality. Furthermore, the true picture of correlation between fiber cotton grade and traits is reflected from direct and indirect effects to perceive the most influencing characters to be utilized as selection criteria in cotton breeding program. Path coefficient analysis provides an effective means of partitioning correlation coefficients into unidirectional pathways and alternate pathways thus permitting a critical examination of specific factors that produce a given correlation which can be successfully **Salahuddin et al (2010)**. In the last quarter of the twentieth century, technology advances were made to quantify cotton quality for classification and research purposes. Cotton classification is now performed by Standardized Instruments for Testing of Cotton (SITC), the most common of which is the Uster High Volume Instrument (HVI) while, there are many automated techniques available for measuring the physical properties of cotton, the manual reference methods are still relevant as well (**Delhom et al 2018**). In this study the fiber attributes were estimated by Cotton Classifying System Version 5.2 (CCS V5.2). The use of CCS V5.2 in Egyptian cotton classing and marketing would provide credible and reliable determination of the real quality of cotton, which would coincide with the actual spinning value and utility of cotton fibers. This in turn would determine a fair price for cotton in the commercial transactions in cotton market.

The objective of the present study was designed to provide information and understand the relationship of fiber cotton grade and its related characters and to partition the phenotypic correlations into their direct and indirect effects and to evaluate the relative importance of the cotton characteristics contributing to fiber cotton grade quality.

MATERIALS AND METHODS

The materials used in this study were four commercial varieties of Egyptian cotton; two (Giza 86 and Giza 90) belonging to the long staple class and the others (Giza 88 and Giza 92) belonging to the extra-long staple category **(Table, 1)**.

According to the local classification system, nine lint cotton grades namely: Fully Good (FG), Good/Fully Good (G/FG), Good (G), Fully Good Fair/Good (FGF/G), Fully Good Fair (FGF), Good Fair/ Fully Good Fair (GF/FGF), Good Fair (GF), Fully Fair/Good Fair (FF/GF) and Fully Fair (FF) were used for each cotton variety. Thus Fully Good (FG) is the top quality grade and the others are progressively lower; i.e. Fully Fair (FF) is the lowest grade. Nevertheless, the samples representing the different grades of the aforementioned varieties were taken from the Egyptian cotton production and marketing seasons of 2015 and 2016. Each lint grade sample was presented by 3 replications. Cotton fiber tests were performed at laboratories of the Egyptian & International Cotton Classification Center (EICCC), Cotton Grading Department (CGD), Cotton Research Institute (CRI), Agricultural Research Center (ARC), Giza, Egypt. Fiber tests were carried out under controlled atmospheric condition of 65% ± 2 relative to humidity and 21ºc ± 2 temperature. Fiber properties were measured by using the Cotton Classifying System Version-5 instrument (CCS-V5). Data were collected for the following characteristics; reflectance degree (Rd%), yellowness (+b), trash%, dust%, fiber fragments%, total trash% (trash, dust, fiber fragments), No. of neps and micronaire value.

Insignificant differences existed between the experimental errors of the two seasons and therefore a combined analysis was performed over two seasons. Statistical procedures used in this study were done according to completely randomized design as outlined by **Snedecor** and **Cochran (1980)**. The phenotypic correlation coefficients for all possible

Table 1. Code number, genotypes, cotton category, pedigree and origin of four Egyptian cotton genotypes used in this study

Code no.	Genotypes	Cotton category	Pedigree and origin
1	Giza 86	Long stable	Giza 75 x Giza 81
2	Giza 90	Long stable	Giza 83 x Dandara
3	Giza 88	Extra-long stable	(Giza 77 x Giza 45)
4	Giza 92	Extra-long stable	Giza 84(Giza 74 x Giza 68)

pairs of the sixteen characters were determined according to **Dewey and Lu (1959).** Partitioning correlation coefficients into direct and indirect effects as well as the relative importance (RI%) at phenotypic level was made by determining path coefficients using the method given also by **Dewey** and **Lu (1959)**.

RESULTS AND DISCUSSION

A. Mean square estimates

Mean squares from the analyses of variance for nine grades of Giza 86 and Giza 90 (long staple) and Giza 88 and Giza 92 (extra-long stable) cotton varieties as combined analysis over two seasons were detected in **Tables 2, 3, 4 and 5**. Results indicate highly significant mean square values for the all studied characters; i.e. reflectance degree (Rd %), yellowness (+b), trash%, dust%, fiber fragments%, total trash%, No. of neps and micronaire value (with some exceptions), revealing the presence of sufficient genetic variability in the studied grades. Consequently various comparisons suggested to be done are valid and should be conducted to fulfill the objectives of the present study.

B. Mean performance of genotypes

B.1. Reflectance degree (Rd%) and Yellowness degree (+b).

The Egyptian cottons have a very wide range of intrinsic colors extending from the extra whit color up to the dark creamy color. In between there are light white, chalky white, light creamy and creamy intrinsic colors.

Results in **Table (6)** show significant differences existed in nine lint grades of the four cotton varieties for reflectance degree (Rd %) and yellowness degree (+b) traits in the combined analyses over seasons. Data for reflectance degree revealed that Giza 92 produced the highest mean values (65.81%) followed by Giza 86 (65.00%) and Giza 88 (59.44%), respectively, whereas, the lowest value was recorded by Giza 90 (55.52%) for the same trait. Thus the arrangement in the descending order of the tested varieties; is Giza 92, Giza 86, Giza 88 and Giza 90, respectively. From these results, it became clear that there were significant genetic differences between studied varieties. Concerning yellowness degree (+b), results reveal that Giza 92 produced the lowest degree of yellowness (9.02%) followed by Giza 86 (9.39%) and Giza 88 (11.72%), respectively, whereas, Giza 90 recorded the highest mean value (11.89%) for the same trait and thus, the four tested varieties could ascending ordered regarding yellowness as follows; Giza 92, Giza 86, Giza 88 and Giza 90, respectively. The results also indicate significant genetic differences among these varieties for this trait.

Regarding the nine lint grades for the two traits; reflectance degree was gradually decreased and yellowness degree was gradually increased significantly as the lint grade transfer from FG down to the FF grade for the four tested varieties.

From above results of both reflectance degree and yellowness degree for all studied varieties, the finding of the study clarified that, one account of their color attributes both of Giza 92 followed by Giza 86 recorded highest degree of reflectance and their lowest degree of yellowness proved to have the lightest white. On the contrary Giza 88 and Giza 90 recorded the lowest degree of reflectance and the highest degree for yellowness are the varieties with deepest degree of intensity of yellow color which implies that those two varieties have a dark creamy color. Overall combined analyses showed the highest reflectance degree (67.70%) and the lowest yellowness degree (10.17) at (FG) grade. The overall combined analyses recorded lowest values of reflectance degree (56.26%) and highest yellowness degree (10.98) were recorded at (FF) grade. **Mahgoub et al (1985)** reported that the most important factors with influenced grade evaluation with percent reflectance (RD %) in some Egyptian cotton varieties. There was a tendency of decrease

Table 2. Mean squares for studied characters of nine grades in Giza 86 long staple cotton variety as combined over two seasons

Mean squares									
S.V	df	Characters							
		Reflectance degree (Rd%)	Yellowness (+b)	Trash (%)	Dust (%)	Fiber fragments (%)	Total trash (%)	No. of neps	Micronaire value
Seasons (S)	1	11.20**	11.2067**	24.0934**	0.952**	2.8982**	71.139**	271.1296	0.0074
Grades (G)	8	0.7944**	0.7944**	71.9119**	0.3577**	0.1537**	87.076**	38860.5**	1.0562**
S X G	8	0.125	0.1250	4.6334**	0.0455*	0.0765**	5.766**	1136.0463	0.0174
Error	36	0.1035	0.1035	0.7811	0.0203	0.0184	0.8712	578.7222	0.0267

Table 3. Mean squares for studied characters of nine grades in Giza 90 long staple cotton variety as combined over two seasons

Mean squares									
S.V	df	Characters							
		Reflectance degree (Rd%)	Yellowness (+b)	Trash (%)	Dust (%)	Fiber fragments (%)	Total trash (%)	No. of neps	Micronaire value
Seasons (S)	1	26.3202*	3.2757**	8.0350**	0.0058	0.6801**	19.4280**	66953.22**	0.4356
Grades (G)	8	86.7287**	1.4183**	271.177**	0.2829**	0.0048**	287.0113**	27433.44**	1.0781**
S X G	8	7.3123	0.1866	9.0305**	0.0745**	0.0060**	9.2183**	2833.193**	0.1156
Error	36	5.4130	0.1665	0.6941	0.0202	0.0010	0.7881	356.3273	0.1092

Table 4. Mean squares for studied characters of nine grades in Giza 88 extra-long staple cotton variety as combined over two seasons

Mean squares									
S.V	df	Characters							
		Reflectance degree (Rd%)	Yellowness (+b)	Trash (%)	Dust (%)	Fiber fragments (%)	Total trash (%)	No. of neps	Micronaire value
Seasons (S)	1	29.9564*	0.0019	33.2761**	1.0334**	0.0379*	30.63**	1300.46*	0.1049
Grades (G)	8	136.14**	0.5317**	220.70**	0.2339**	0.0219*	229.50**	10871.9**	0.7128**
S X G	8	17.6**	0.1643	24.328**	0.0676**	0.0483**	26.09**	131.05	0.0878
Error	36	5.6929	0.1434	1.0603	0.0138	0.0083	1.128	214.57	0.1592

Table 5. Mean squares for studied characters of nine grades in Giza 92 extra-long staple cotton variety as combined over two seasons

S.V	df	Mean squares							
		Characters							
		Reflectance degree (Rd%)	Yellowness (+b)	Trash (%)	Dust (%)	Fiber fragments (%)	Total trash (%)	No. of neps	Micronaire value
Seasons (S)	1	34.2408*	8.0119**	1.7209	0.325**	0.4574**	0.3585	60345.16**	0.084
Grades (G)	8	122.612**	0.1506	216.9**	0.028*	0.0719	224.19**	27272.34**	0.9317**
S X G	8	4.7949	0.3489	3.302	0.022*	0.0524	3.0266	1784.9813	0.0885
Error	36	6.8898	0.2493	2.1872	0.0096	0.0510	3.6104	996.4788	0.0929

Table 6. Mean performance for reflectance degree (Rd %) and yellowness degree (+b) for nine lint grades of two long staple (Giza 86 and Giza 90) and two extra-long staple (Giza 88 and Giza 92) cotton varieties as combined over two seasons

Grades	Reflectance degree (Rd %)					Yellowness (+b)				
	Varieties					Varieties				
	G 86	G 90	G 88	G 92	Mean	G 86	G 90	G 88	G 92	Mean
FG	71.68	59.12	67.22	72.77	67.70	9.00	11.58	11.24	8.85	10.17
G/FG	70.67	60.72	64.87	72.50	67.19	9.10	11.60	11.37	9.10	10.29
G	66.60	58.48	62.54	68.60	64.06	9.05	11.55	11.57	9.25	10.35
FGF/G	65.48	57.97	58.27	65.45	62.29	9.30	11.63	11.62	8.83	10.35
FGF	64.45	56.27	55.59	65.38	61.21	9.10	11.67	11.87	8.92	10.39
GF/FGF	63.58	53.18	53.43	62.65	58.95	9.52	11.53	11.89	9.12	10.51
GF	60.77	51.52	54.11	61.83	57.78	9.95	12.08	11.78	9.07	10.72
FF/GF	60.85	52.08	51.23	61.53	57.54	9.55	12.65	12.10	8.85	10.79
FF	60.92	50.32	49.12	61.55	56.26	9.90	12.75	12.08	9.18	10.98
Mean	65.00	55.52	59.44	65.81	61.44	9.39	11.89	11.72	9.02	10.51
L.S.D 5%	1.40	1.28	1.32	1.45	1.41	0.18	0.23	0.21	0.28	0.23
Min	55.30	48.90	49.70	56.70	48.90	8.20	10.30	10.77	7.20	7.20
Max	73.60	64.70	70.30	74.60	74.60	10.80	12.90	12.60	10.30	12.90

Where: Fully Good (FG), Good/Fully Good (G/FG), Good (G), Fully Good Fair/Good (FGF/G), Fully Good Fair (FGF), Good Fair/ Fully Good Fair (GF/FGF), Good Fair (GF), Fully Fair/Good Fair (FF/GF) and Fully Fair (FF).

in percent reflectance as the classified grade was decreased. **Kamal et al (1990)** stated that within any given variety, lightness was found to have relevant relation to the grade of cotton while there was no consistent pattern grade. **Hussein et al (2013)** concluded that lightness percent expressed as percent reflectance (RD%) could be sufficient enough as an individual criterion to signalize and signify the grade of Egyptian cottons and hence predicting that grade. Also similar results were found by **McAlister and Rogers (2005), Nasser (2007) and Ebaido et al (2017).**

B.2. Trash% and Dust %

Trash and dust content refers to the amount of impurities contained in a cotton sample. These impurities result from many factors, such as cotton growing environment, planting practice, harvesting methods and ginning procedures. Trash in form of husks, leaves, stalk and seed-coat fragments have a detrimental effect on fiber, yarn and fabric quality.

Results in **Table (7)** indicate significant differences among the nine lint grades in trash% and dust% for the four varieties over the two seasons.

With respect to varieties, the lowest mean values of trash% was by Giza 86 followed by Giza 88 and Giza 90), while the highest was for Giza 92. So, the arrangement in ascending order according to trash% was Giza 86, Giza 88, Giza 90 and Giza 92. Concerning Dust%, the lowest mean performance values were found by Giza 92 followed by Giza 88 and Giza 90, while the highest one Giza 86. Thus, the arrangement of varieties in ascending order according to dust% is the extra-long staple variety Giza 92 and Giza 88 followed by the long staple variety Giza 90 and Giza 86, respectively.

With regard to the nine lint grades in the trash% and dust% were gradually increased significantly as transfer for all tested varieties from FG down to the FF grade. Overall the two seasons for trash% and dust% were the lowest for (FG) grade with means of 1.93 and 0.30%, while were the highest for (FF) grade with values of 17.56 and 0.73% for the two traits, respectively. **Nasir et al (2012)** found that, fiber physical properties, yarn processing efficiency and quality of end product potentially affect the possible trash practiced in handling during the picking, ginning and baling processes. **Hussein et al (2015)** showed high variation among varieties and within the same variety in trash%. **Hussein et al (2014)** stated that any increase in trash and dust resulted in a decrease of clean ability and the cleaning degree.

B.3. Fiber fragments % and Total trash%

Results presented in **Table (8)** demonstrate significant differences among the nine lint grades of the four cotton varieties in fiber fragments% and total trash%. Concerning the studied varieties, data recorded that the extra-long staple cotton varieties Giza 88 and Giza 92 gave the lowest fiber fragments%. On the other side, long staple cotton variety Giza 86 followed Giza 90 recorded the highest fiber fragments%. Thus, the arrangement varieties in ascending order according to fiber fragments% for extra-long staple varieties Giza 88 and Giza 92 followed by the long staple varieties Giza 86 and Giza 90, respectively. With regard to total trash%, results for cotton varieties revealed that long staple cotton variety Giza 86 gave the lowest mean value followed by the extra- long staple cotton varieties Giza 88 and Giza 92, while Giza 90 long staple cotton variety gave the highest total trash%. Thus, the arrangement of varieties in ascending order according to total trash% was Giza 86 followed by Giza 88, Giza 92 and Giza 90, respectively.

Table 7. Mean performance for Trash% and Dust% for nine lint grades of two long staple (Giza 86 and Giza 90) and two extra-long staple (Giza 88 and Giza 92) cotton varieties as combined over two seasons

Grades	Trash%					Dust%				
	Varieties					Varieties				
	G 86	G 90	G 88	G 92	Mean	G 86	G 90	G 88	G 92	Mean
FG	2.11	1.68	2.36	1.56	1.93	0.38	0.43	0.20	0.21	0.30
G/FG	1.88	2.59	4.09	2.87	2.86	0.38	0.34	0.32	0.24	0.32
G	5.27	3.79	4.23	5.61	4.72	0.51	0.40	0.17	0.21	0.32
FGF/G	6.47	8.11	6.51	10.77	7.96	0.61	0.51	0.43	0.19	0.43
FGF	7.86	11.48	7.92	13.44	10.17	0.47	0.54	0.61	0.30	0.48
GF/FGF	8.06	14.55	10.25	14.50	11.84	0.83	0.60	0.64	0.38	0.61
GF	8.99	15.50	12.54	14.75	12.94	0.89	0.69	0.70	0.32	0.65
FF/GF	9.46	17.91	16.41	15.43	14.80	0.96	0.74	0.59	0.33	0.65
FF	12.54	19.07	20.33	18.32	17.56	0.96	1.05	0.58	0.35	0.73
Mean	6.96	10.52	9.40	10.80	9.42	0.66	0.59	0.47	0.28	0.50
L.S.D 5%	0.49	0.46	0.57	0.57	0.62	0.08	0.08	0.13	0.05	0.07
Min	1.39	1.12	2.10	0.95	0.95	0.14	0.09	0.04	0.12	0.04
Max	16.50	19.83	25.94	19.50	25.94	1.63	1.65	2.54	0.71	1.65

Where: Fully Good (FG), Good/Fully Good (G/FG), Good (G), Fully Good Fair/Good (FGF/G), Fully Good Fair (FGF), Good Fair/ Fully Good Fair (GF/FGF), Good Fair (GF), Fully Fair/Good Fair (FF/GF) and Fully Fair (FF).

Table 8. Mean performance for Fiber fragments% and Total trash% for nine lint grades of two long staple (Giza 86 and Giza 90) and two extra-long staple (Giza 88 and Giza 92) cotton varieties as combined over two seasons

Grades	Fiber fragments%					Total trash%				
	Varieties					Varieties				
	G 86	G 90	G 88	G 92	Mean	G 86	G 90	G 88	G 92	Mean
FG	0.11	0.15	0.06	0.03	0.09	2.76	2.66	2.73	1.89	2.51
G/FG	0.27	0.15	0.05	0.05	0.13	2.70	3.06	4.67	3.33	3.44
G	0.41	0.18	0.04	0.08	0.18	6.42	4.43	4.83	5.99	5.41
FGF/G	0.41	0.18	0.09	0.13	0.20	7.63	8.92	7.29	10.21	8.51
FGF	0.47	0.20	0.13	0.13	0.23	9.04	12.40	8.79	14.05	11.07
GF/FGF	0.47	0.20	0.12	0.14	0.23	9.66	15.43	11.19	15.13	12.85
GF	0.53	0.21	0.14	0.16	0.26	10.69	16.54	13.55	15.51	14.07
FF/GF	0.61	0.22	0.23	0.17	0.31	11.19	18.99	17.22	15.98	15.84
FF	0.65	0.22	0.32	0.42	0.40	14.10	20.39	21.10	18.76	18.59
Mean	0.44	0.19	0.13	0.14	0.22	8.24	11.42	10.15	11.20	10.25
L.S.D 5%	0.07	0.02	0.05	0.12	0.08	0.52	0.49	0.60	0.59	0.72
Min	0.08	0.04	0.02	0.01	0.01	2.25	1.48	2.44	1.25	1.25
Max	1.29	0.43	0.88	1.79	1.79	19.07	20.89	26.91	19.87	26.91

Where: Fully Good (FG), Good/Fully Good (G/FG), Good (G), Fully Good Fair/Good (FGF/G), Fully Good Fair (FGF), Good Fair/ Fully Good Fair (GF/FGF), Good Fair (GF), Fully Fair/Good Fair (FF/GF) and Fully Fair (FF).

The nine lint grades in four varieties showed significant differences of fiber fragments% and total trash%. Mean performance values were gradually increased as transfer in all the tested varieties from Fully Good (FG) grade down to Fully Fair (FF) grade. Regarding overall values in fiber fragments% and total trash% were the lowest by grade (FG). On the other hand, the highest values were found by grade (FF). **Kamal et al (1991)** declared that average trash content expressed in terms of percent trash area and trash grade increased steadily as the classified grade decreased, it was also found that, within any given nominal grade there was a pronounced divergence in the values of the criteria determining that given grade secured from different growing locations. **Hussein et al (2014)** stated that any increase in trash and fiber fragments resulted in a decrease of clean ability and the cleaning degree.

B.4. Number of Neps and Micronaire value

Data in **Table (9)** shows significant differences between cotton varieties and the nine lint grads in No. of neps and micronaire value.

Number of neps in the yarn is one of the important reasons that negatively affect its quality properties, and it is considered a source of many problems when making cotton, which affects the quality of textiles. With respect to investigated varieties, the extra-long staple variety Giza 88 followed by Giza 92 recorded the lowest mean values; 87.46 and 223.05, respectively, for No. of neps. Long staple cotton varieties Giza 86 and Giza 90 exhibited highest mean values of 264.17 and 284.51, respectively for the same trait. The variation in No. of neps is related to genetic of the cotton varieties. In general, the higher the lint grades the lower neps content. For micronaire value, results in **Table (9)** indicate that Giza 92 exhibited lowest mean value (3.43) followed by Giza 90 (3.63) and Giza 88 (3.77) while, Giza 86 gave the highest mean value of micronaire (4.18). These results indicate that Giza 92 was the finest cotton in comparison with the other varieties while, Giza 86 was the coarsest cotton in comparison with the other varieties.

The nine lint grades showed significant differences over seasons for number of neps and micronaire value. Mean performance values were gradually increased for number of neps while gradually decreased for micronaire value with significant as transfer for all tested varieties from (FG) grade down to Fully Fair (FF) grade. Lowest overall values for number of neps recorded by grade (FG) with mean of 124.96, whereas, the highest value was by grade

Table 9. Mean performance for No. of neps and Micronaire value for nine lint grades of two long staple (Giza 86 and Giza 90) and two extra-long staple (Giza 88 and Giza 92) cotton varieties as combined over two seasons

Grades	No. of neps					Micronaire value				
	Varieties					Varieties				
	G 86	G 90	G 88	G 92	Mean	G 86	G 90	G 88	G 92	Mean
FG	155.67	182.50	30.84	130.84	124.96	4.65	4.30	4.32	4.02	4.41
G/FG	172.00	196.67	50.84	133.67	138.29	4.63	4.20	4.17	3.97	4.37
G	234.67	246.84	50.50	158.34	172.58	4.47	3.98	3.99	3.68	4.16
FGF/G	193.17	262.34	68.84	215.33	184.92	4.38	3.63	3.97	3.58	4.06
FGF	251.84	290.84	82.17	252.67	219.38	4.32	3.49	3.55	3.51	3.85
GF/FGF	321.34	319.34	95.67	248.83	246.29	4.18	3.27	3.56	3.44	3.74
GF	348.83	335.58	117.00	279.17	270.14	3.83	3.25	3.55	3.17	3.60
FF/GF	337.50	351.33	130.00	274.67	273.38	3.61	3.26	3.44	2.73	3.43
FF	362.50	375.17	161.34	313.98	303.24	3.55	3.29	3.38	2.71	3.41
Mean	264.17	284.51	87.46	223.05	214.80	4.18	3.63	3.77	3.43	3.89
L.S.D 5%	13.28	10.42	8.09	17.42	13.22	0.09	0.18	0.22	0.22	0.18
Min	147.00	130.00	19.00	99.00	19.00	3.12	2.78	2.78	2.10	2.78
Max	437.00	395.00	193.00	432.00	437.00	4.92	4.84	4.84	4.87	4.92

Where: Fully Good (FG), Good/Fully Good (G/FG), Good (G), Fully Good Fair/Good (FGF/G), Fully Good Fair (FGF), Good Fair/ Fully Good Fair (GF/FGF), Good Fair (GF), Fully Fair/Good Fair (FF/GF) and Fully Fair (FF).

(FF) with mean of 303.24. On the contrary, for micronaire value, the highest value recorded by grade (FG) with mean of 4.41, whereas, the lowest value was by grade (FF) with mean of 3.41. **Mansour (1984)** explain that, high lint grades produced yarns of lower number of neps. **Van der Sluijs and Hunter, (1999)** stated that in general, the higher the lint grades the lower neps content. **Hussein et al (2015)** recorded that in the same variety, main effect of micronaire value on cotton grade is the maturity, whereas between varieties the main effect is the fineness. **Hassan and Ibrahim (2018)** recorded that micronaire value had the greatest influence on number of neps for the extra-long and long staple cotton varieties. Also, these results are in agreement with those of **Nasser (2007)** and **Ebaido et al (2012).**

C. Correlation and path coefficient analysis studies

C.1. Correlation studies

The phenotypic correlation coefficients provides information about interrelationships between cotton grades and some important attributes by which the breeder can design an successful program to improve cotton fiber quality properties. For the analysis of cotton grade attributes, it was first necessary to calculate the simple phenotypic correlation coefficients among the nine traits in all possible combinations with the objective to drive information about the nature and intensity of the relationship among different characters combinations.

For long staple cotton varieties Giza 86 and Giza 90, the correlation values presented in **Tables (10 and 11)** revealed that highly significant negative correlation values existed between fiber cotton grades and each of yellowness (+b), trash%, dust%, fiber fragments%, total trash% and No. of neps for the two varieties except of fiber fragments% in Giza 90 variety which was insignificant. Positive and highly significant correlation values existed between fiber cotton grades with reflectance degree (Rd %) and micronaire value. Highly significant negative correlation values were found between reflectance degree and all studied traits except micronaire value which had highly significant positive correlation for Giza 86 and Giza 90. Yellowness degree recorded highly significant negative correlation with fiber fragments% and micronaire value for Giza 86.

Table 10. Correlation coefficients between grades and fiber quality properties of Giza 86 long staple cotton variety as combined analyses over two seasons

Characters		1	2	3	4	5	6	7	8	9
Grade	1	0								
Reflectance degree (Rd%)	2	0.834**	0							
Yellowness (+b)	3	-0.467**	-0.399**	0						
Trash%	4	-0.901**	-0.783**	0.241	0					
Dust%	5	-0.719**	-0.637**	0.09	0.761**	0				
Fiber fragments%	6	-0.418**	-0.464**	-0.337*	0.547**	0.607**	0			
Total trash%	7	-0.885**	-0.779**	0.171	0.992**	0.811**	0.631**	0		
No. of neps	8	-0.910**	-0.767**	0.413**	0.852**	0.741**	0.413**	0.844**	0	
Micronaire value	9	0.913**	0.775**	-0.434**	-0.814**	-0.697**	-0.367**	-0.805**	-0.818**	0

Table 11. Correlation coefficients between grades and fiber quality properties of Giza 90 long staple cotton variety as combined analyses over two seasons

Characters		1	2	3	4	5	6	7	8	9
Grade	1	0								
Reflectance degree (Rd%)	2	0.809**	0							
Yellowness (+b)	3	-0.591**	-0.396**	0						
Trash%	4	-0.964**	-0.826**	0.491**	0					
Dust%	5	-0.726**	-0.626**	0.523**	0.689**	0				
Fiber fragments%	6	-0.212	-0.284*	-0.233	0.265	0.043	0			
Total trash%	7	-0.961**	-0.833**	0.483**	0.999**	0.705**	0.288*	0		
No. of neps	8	-0.819**	-0.622**	0.651**	0.786**	0.520**	-0.22	0.767**	0	
Micronaire value	9	0.734**	0.587**	-0.248	-0.710**	-0.594**	-0.315*	-0.718**	-0.447**	0

On the other side, highly significantly positive relationship between yellowness and trash%, dust%, total trash% and No. of neps for Giza 90, as well as No. of neps in Giza 86. Highly significant positive correlation values between trash% with dust%, fiber fragments%, total trash% and No. of neps, whereas negative correlation with micronaire value in the two varieties. Dust% recorded highly significant positive correlation with fiber fragments%, total trash% and No. of neps for two varieties, except fiber fragments% for Giza 90 was insignificant; the relationship between dust% and micronaire value for Giza 86 and Giza 90 recorded highly significant negative correlation. Highly significant positive correlation values between fiber fragments% with total trash% and No. of neps for Giza 86 as well as total trash% for Giza 90, while fiber fragments% showed highly significant negative value with micronaire value for Giza 86 and Giza 90. Total trash% recorded highly significant positive and negative correlation values with No. of neps and micronaire value, respectively, for the two varieties. Highly significant negative correlated between No. of neps and micronaire value for the two varieties.

For extra-long staple cotton varieties Giza 88 and Giza 92, results in **Tables 12 and 13** explain that highly significant negative correlation values existed between fiber cotton grade and all studied traits for the two varieties except fiber fragments% in the two varieties and yellowness (+b) in Giza 92. Highly significant positive correlation between cotton grade with reflectance degree and micronaire value for Giza 88 and Giza 92 varieties, the relationship between fiber cotton grade and fiber fragments were insignificant for the two varieties. Reflectance degree (Rd%) shows highly significant negative correlation with yellowness, trash%, dust%, total trash% and No. of neps for Giza 88 while, highly significant positive correlation with micronaire value and had insignificant correlation with fiber fragments% for the same variety. For Giza 92, data recorded highly significant negative correlation values existed between fiber cotton grade and trash%, total trash% and No. of neps, whereas highly significant positive correlation with micronaire value, On the other hand, insignificant phenotypic correlation between reflectance degree with yellowness, dust% and fiber fragments%. Yellowness (+b) recorded highly significant positive correlation with trash%, dust%, total trash% and No. of neps for Giza 88, as well as dust% for Giza 92 while, micronaire value for Giza 88 and No. of neps for Giza 92 recorded highly significant negative correlations with yellowness. Highly significant positive correlations values were found between trash% with dust%, total trash% and No. of neps, and negative values with micronaire value for Giza 88 and Giza 92. Dust% recorded highly significant positive correlation with total trash% and No. of neps for Giza 88 and with fiber fragments and total trash% for Giza 92, whereas dust% had significant negative values with micronaire value for the two varieties.

Fiber fragments% revealed insignificant correlation coefficient values with total trash%, No. of neps and micronaire value in the two varieties. Total trash% recorded highly significant positive and negative correlated with No. of neps and micronaire value, respectively, for the two varieties. Highly significant negative correlation was found between No. of neps and micronaire value for Giza 88 and Giza 92.

From above results it could be noted that, all correlation coefficients between fiber cotton grade and the other characters either in the positive or in the negative direction were highly significant at the 5 and 1% levels in the four varieties. The characters proved to be positively correlated with grade (reflectance degree and micronaire value) are desirable from the stand point of the cotton spinner. On the contrary the characters negatively associated with grade (yellowness, trash%, dust%, total trash% and No. of neps) are detrimental in cotton processing. Therefore the producer should be gave more attention to raise the level of grade in Egyptian cotton by the improved cultural practices, harvesting, storage and ginning, etc.

Hussein et al (2013) stated that lightness expressed as percent reflectance (Rd%) evidently excelled all other color attributes with respect to their correlations with lint cotton grade and their contributions to the variation in grade of either the white or the creamy colored Egyptian cotton varieties. Hence it was concluded that lightness per se expressed as percent reflectance (Rd %) could be sufficient enough as an individual criterion to signalize and signify the grade of Egyptian cottons, and hence predicting that grade. **Hussein et al (2015)** revealed that all simple correlation coefficients between cotton contaminants (trash count, fiber fragments and dust%) and micronaire value were negative, while with neps was positive. He also stated that the values of simple correlation coefficient per se are not always good enough to estimate the relationship between two variables.

Table 12. Correlation coefficients between grades and fiber quality properties of Giza 88 extra-long staple cotton variety as combined over two seasons

Characters		1	2	3	4	5	6	7	8	9
Grade	1	0								
Reflectance degree (Rd%)	2	0.845**	0							
Yellowness (+b)	3	-0.602**	-0.577**	0						
Trash%	4	-0.907**	-0.814**	0.572**	0					
Dust%	5	-0.571**	-0.618**	0.352**	0.634**	0				
Fiber fragments%	6	0.061	-0.045	0.07	-0.178	-0.19	0			
Total trash%	7	-0.911**	-0.820**	0.576**	0.999**	0.650**	-0.158	0		
No. of neps	8	-0.933**	-0.835**	0.578**	0.888**	0.558**	-0.138	0.886**	0	
Micronaire value	9	0.654**	0.650**	-0.429**	-0.587**	-0.460**	0.267	-0.587**	-0.632**	0

Table 13. Correlation coefficients between grades and fiber quality properties of Giza 92 extra-long staple cotton variety as combined over two seasons.

Characters		1	2	3	4	5	6	7	8	9
Grade	1	0								
Reflectance degree (Rd%)	2	0.825**	0							
Yellowness (+b)	3	-0.035	0.147	0						
Trash%	4	-0.933**	-0.838**	0.04	0					
Dust%	5	-0.384**	-0.162	0.362**	0.339*	0				
Fiber fragments%	6	-0.054	-0.064	0.158	0.087	0.304*	0			
Total trash%	7	-0.927**	-0.829**	0.056	0.990**	0.371**	0.13	0		
No. of neps	8	-0.789**	-0.738**	-0.288*	0.782**	0.006	-0.128	0.772**	0	
Micronaire value	9	0.769**	0.604**	0.079	-0.620**	-0.280*	0.027	-0.634**	-0.649**	0

C.2. Path coefficient analysis studies

The analyses of path coefficient has been made to identify the important fiber cotton grade attributes by estimating the direct effect of the contributing characters to fiber cotton grade and separating the direct from the indirect effects through other related characters by partitioning the correlation coefficient and finding out the relative important of different characters as selection criteria.

Direct and indirect path coefficient analysis for Giza 86 and Giza 90 (long staple) and Giza 88 and Giza 92 (extra-long staple) cotton varieties are presented in **Table 14**. The results of direct effects shows that the total trash% followed by micronaire value came in the first order and recorded negative for total trash% and positive for micronaire value strong direct path coefficient effects on fiber cotton grades, whereas, the direct effects of reflectance degree and yellowness on fiber cotton grades came in the second order which recorded positive and negative small magnitude effects for the two traits, respectively, for all studied varieties.

The indirect path coefficient effects for Egyptian cotton varieties Giza 86, Giza 90, Giza 88 and Giza 92 are presented in **Table 14.** The indirect effects for reflectance degree (Rd%) and micronaire value via total trash% were positive and strong on fiber cotton grads in the all tested varieties while, reflectance degree via micronaire value were positive moderate effects on fiber cotton grades in Giza 86 and Giza 90. On the contrary, negative and large indirect effects for yellowness degree via total trash% on fiber cotton grades for Giza 90 and Giza 88.

The components of direct and indirect effects and their relative importance as contribution percentages of fiber cotton grade variations in long staple (Giza 86 and Giza 90) and extra-long staple (Giza 88 and Giza 92) cotton varieties are presented in **Table (15)**. The results revealed that the four characters and their interactions as sources of fiber cotton grades variation were responsible 83.177% for Giza 86, 78.504% for Giza 90, 87.017% for Giza 88 and 92.024% for Giza 92, while the residual effects assumed to be 16.823, 21.496, 12.983 and 7.976%, respectively, for the four studied varieties.

The main sources of fiber cotton grade variations arranged according to their importance, the direct effect of total trash% came in the first order were recorded by varieties Giza 92, Giza 88, Giza 90 and Giza 86, respectively, followed by direct effect of micronaire value which recorded by varieties Giza 86, Giza 92, Giza 90 and Giza 88, while the direct effect of reflectance degree and yellowness degree came in the last order on fiber cotton grades. The joint effect of total trash% with micronaire value recorded by Giza 86, Giza 92, Giza 90, and Giza 88, respectively. The joint effects of reflectance degree via total trash% recorded by Giza 88, Giza 92, Giza 86 and Giza 90. Whereas, the rest of the joint affects for other traits were the lowest on the fiber cotton grades. From above results, it could be concluded that total trash% and micronaire value as well as of reflectance degree and their interactions were the most contributing and influencing of fiber cotton grades. **Hussein et al (2013)** stated that the values of determination coefficients (R %) for color lightness (Rd %) appeared to have the most influence than any other color attribute on the variation in lint cotton grade. Lightness (Rd %) accounted for 93.9% of the variation in lint grade in the white colored varieties and 89.5% of that variation in the creamy colored varieties. Similar results found by **Beheary et al (2019)**.

From the above results, it could be concluded that the rank of cotton lint grades are based on fiber quality and that lint grade decreased as; yellowness degree, trash%, dust%, fiber fragments% and number of neps increased and increased as; reflectance degree and micronaire values decreased. Total trash% and micronaire value as well as reflectance degree and their interactions were the most contributing and influencing factors in fiber cotton grade. Also these properties and their joint effects are prevailing factors which affect the personal judgment of the grader at evaluating the cotton grade.

Table 14. Partitioning of the phenotypic correlation coefficient between fiber cotton grades and its related attributes of long staple (Giza 86 and Giza 90) and extra-long staple (Giza 88 and Giza 92) cotton varieties as combined over two seasons

Source of variation	Varieties			
	Giza 86	Giza 90	Giza 88	Giza 92
1-Rreflectance degree (Rd%)				
Direct effect:	0.1050	0.0360	0.2200	0.1320
Indirect effect via yellowness	0.0726	0.0721	0.0381	-0.0062
Indirect effect via total trash	0.3685	0.6248	0.5125	0.5214
Indirect effect via micronaire value	0.2891	0.2213	0.0748	0.1776
Total	**0.8352**	**0.9541**	**0.8453**	**0.8248**
2-Yellowness degree (+b)				
Direct effect :	-0.1820	-0.1820	-0.0660	-0.0420
Indirect effect via degree of reflectance	-0.0419	-0.0143	-0.1269	0.0194
Indirect effect via total trash	-0.0809	-0.3623	-0.3600	-0.0352
Indirect effect via micronaire value	-0.1619	-0.0935	-0.0493	0.0232
Total	**-0.4667**	**-0.6520**	**-0.6023**	**-0.0346**
3-Total trash%				
Direct effect :	-0.4730	-0.7500	-0.6250	-0.6290
Indirect effect via degree of reflectance	-0.0818	-0.0300	-0.1804	-0.1094
Indirect effect via yellowness	-0.0311	-0.0879	-0.0380	-0.0024
Indirect effect via micronaire value	-0.3003	-0.2707	-0.0675	-0.1864
Total	**-0.8862**	**-1.1386**	**-0.9109**	**-0.9272**
4-Micronaire value				
Direct effect :	0.3730	0.3770	0.1150	0.2940
Indirect effect via degree of reflectance	-0.0814	0.0211	0.1430	0.0797
Indirect effect via yellowness	0.0624	0.0451	0.0283	-0.0033
Indirect effect via total trash	0.3808	0.5385	0.3669	0.3988
Total	**0.7348**	**0.9818**	**0.6532**	**0.7692**

Table 15. The components of direct and indirect effects and their relative importance as contribution percentages of fiber cotton grades variation of long staple (Giza 86 and Giza 90) and extra-long staple (Giza 88 and Giza 92) cotton varieties as combined over two seasons

Source of variation	Giza 86		Giza 90		Giza 88		Giza 92	
D irect	CD*	RI%**	CD*	RI%**	CD*	RI%**	CD*	RI%**
Reflectance degree (X1)	0.011	0.983	0.001	0.074	0.048	4.840	0.017	1.730
Yellowness degree (X2)	0.033	2.954	0.033	1.888	0.004	0.436	0.002	0.175
Total trash (X3)	0.224	19.951	0.563	32.067	0.391	39.063	0.396	39.283
Micronaire value (X4)	0.139	12.407	0.142	8.102	0.013	1.323	0.086	8.582
Indirect								
(X1) x (X2)	0.015	1.360	0.005	0.296	0.017	1.676	0.002	0.162
(X1) x (X3)	0.077	6.900	0.045	2.564	0.226	22.550	0.138	13.668
(X1) x (X4)	0.061	5.413	0.016	0.908	0.033	3.289	0.047	4.655
(X2) x (X3)	0.029	2.625	0.132	7.517	0.048	4.752	0.003	0.294
(X2) x (X4)	0.059	5.255	0.034	1.940	0.007	0.651	0.002	0.194
(X3) x (X4)	0.284	25.330	0.406	23.147	0.084	8.438	0.234	23.282
Residual	0.189	16.823	0.377	21.496	0.130	12.983	0.080	7.976
Total	**1.121**	**100.000**	**1.754**	**100.000**	**1.000**	**100.000**	**1.007**	**100.000**

CD* : Coefficient of determination

RI%** : Relative importance

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العلاقة بين الرتبة وبعض الصفات المرتبطة بها فى أصناف القطن المصرى الطويلة والفائقة الطول

[13]

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يهدف هذ البحث الى التعرف على أهم الصفات التى يمكن أستخدامها فى تقييم رتبة القطن وكذلك التعرف على طبيعة العلاقة التى تربط بين رتبة القطن والصفات المرتبطة بها من خلال تقدير معامل الأرتباط المظهرى وكذلك تقدير معامل المرور لتقييم الأهمية النسبية للصفات التي تساهم في تحسين جودة الرتبة فى القطن.

أشتملت هذه الدراسة على أربعة أصناف تجارية أثنين منها تمثل ألأقطان الطويلة (جيزة 86 وجيزة 90)، وأثنين منها تمثل الأقطان فائقة الطول (جيزة 88 وجيزة 92)، وقد تمت الدراسة على تسعة رتب لكل صنف من الأصناف.

تم تقييم الصفات التالية: أنعكاس اللون (Rd%)، درجة الإصفرار (b+)، الشوائب%، المواد الغريبة%، الشوائب الكلية%، شظايا الألياف%، عدد العقد وقيمة الميكرونير بإستخدم جهاز (CCS-V5). وفيما يلى أهم النتائج:

- أوضحت النتائج أن كل من التباين والسلوك الراجع لكل من الأصناف والرتب داخل كل صنف عالية المعنوية لجميع الصفات المدروسة، مما يدل على وجود قدر كبير من الأختلافات الوراثية فيما بين الأصناف وبين الرتب داخل كل صنف.
- أظهرت النتائج وجود زيادة تدريجية فى النسبة المئوية لكل من درجة الإصفرار، الشوائب، المواد الغريبة، الشوائب الكلية، شظايا الألياف،عدد العقد، بينما وجد نقص تدريجى فى قيم أنعكاس اللون (Rd%) وقيمة الميكرونير وذلك بالأنتقال تدريجياً من الرتبة فولى جود (أعلى جودة) حتى الرتبة فولى فير (الأقل جودة) فى جميع الأصناف المدروسة.
- أوضحت النتائج وجود أرتباط سالب وعالى المعنوية بين الرتبة وكل من درجة الإصفرار، الشوائب، المواد الغريبة، الشوائب الكلية وعدد العقد، بينما كان الأرتباط موجب وعالى المعنوية بين الرتبة وكل من أنعكاس اللون (Rd%) وقيمة الميكرونير.
- أوضحت النتائج أن كل من الشوائب الكلية%، وقيمة الميكرونير وكذلك أنعكاس اللون وتفاعلاتهم كانت الأكثر مساهمة وتأثيرًا في ألياف رتبة القطن. أيضا تعتبر هذه الصفات وتأثيراتها المشتركة هي العوامل التي تؤثر على الحكم الشخصي للفراز في تقييم رتبة القطن.

الكلمات المفتاحية: رتب القطن، أقطان طويلة، أقطان فائقة الطول، معامل الأرتباط، معامل المرور

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