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NUMERICAL QUANTIFICATION OF LINT GRADE IN EGYPTIAN COTTON

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Abstract

The materials used in the present study included the 2 long staple varieties Giza 75 and Giza 80 as well as the 2 extra-long staple Giza 76 and Giza 77. A range of lint cotton grades from Fully Fair to Good/Fully Good, in increments of either 1/4 or 1/2 of a grade, was used from each variety.

The values of colour index and grade factor were used as numerical indications of cotton grade in order to secure reliability and accuracy of cotton quality specification. The results obtained indicated that colour index and lint grade were found to correlate strongly and positively in the white coloured cotton varieties Giza 75 and Giza 76, while this correlation was not significant in the creamy coloured varieties Giza 77 and Giza 80. On the other hand, grade factor correlated positively and significantly with lint grade in all studied varieties. In conclusion, grade factor appeared to be an elaborate and credible numerical means that could be used satisfactorily to define and specify the grade and quality of cotton without much reliance on classer's grade, which is mostly subjected to a great deal of contravention and inconsistency, since it is entirely qualitative.

INTRODUCTION

It is widely acknowledged that cotton grade, which is traditionally and

subjectively determined by classers, is a mere approximation of the spinning utility of cotton fibers. This conception is based on the fact that cotton grade is a qualitative or a descriptive means of cotton quality specification. Noteworthy is that Lord (1961) pointed out that grade in Egypt is not absolute but rather a comparative measure of quality among samples of the same variety. Mostly cotton grade is determined by classers without reference to the character of cotton which is a subjective complex attribute that can not be judged by any satisfactory standards. The character of cotton, however, refers to fiber length, length uniformity, strength, drag, fineness or coarseness and softness or harshness. Thus, colour, trash content and preparation or appearance of ginned lint are usually the only criteria taken into consideration to assign and standardize the grade of cotton by classers who depend materially on the capability of their human perception along with their experience and skills. Lack of both experience and skills of classers would result in a misconception of grade standards or an unfamiliarity with those standards, which along with vagaries would render the grading procedure inconsistent. The direct consequence of this practice is a marked contradiction among the different classers with regard to the valuation of the grade of the same cotton sample.

As it has been previously mentioned, colour trash content and appearance of ginned lint are the basic determinants of cotton grade. Further, cotton fiber maturity is another factor with an outstanding importance which should not be ignored when determining the grade of cotton. Kamal *et al.* (1990) indicated that lightness or brilliance of cotton colour (Rd%) was found to have a considerable effect on grade of either the white or the creamy coloured cotton varieties, while the effect of yellowness (+b) was marginal.

With respect to the relationship between trash content and cotton grade, there is an overwhelming agreement regarding the strong inverse relation between these two traits. In this regard, Kamal *et al.* (1987), reported that each of the constituents of non-lint materials, i. e. trash, motes and invisible waste tended to increase progressively with the decrease in cotton grade of Egyptian varieties. As regards the relevance between cotton grade and fiber maturity, it is widely recognized that fairly low cotton grades which are often picked late and mostly infested with pests and diseases tend to comprise a substantially higher proportion of dead and tight locks having poorly developed immature fibers. However, experienced cotton classers are capable of practicing qualitative assessment of

fiber maturity of a cotton sample by hand and eye, since they could detect the various adverse aspects that indicate probable low maturity. In this respect, the significant positive relation of fiber maturity to cotton grade was emphasized by Lord (1961), Ahmed (1977) and Hegab (1978).

In order to steer clear of human bias, attempts had been made to numerically quantify the quality of cotton utilizing the criteria which determine cotton grade. The intention was to realize unbiased and precise determination of quality which would coincide with the actual spinning value of cotton. Nickerson (1951), clarified that a code consisting of measurements for Rd % (percent reflectance) and +b (degree of yellowness), was used in identifying colour classification of equivalent grades of American Upland cotton. The code can be used either in the form of a decimal or a common fraction. For example for Rd = 71 and +b = 10, the code is 71.10 or 71/10. Hegab (1978) referred to that the ratio of reflectance (Rd %) to yellowness (+b), termed as colour index, was calculated for different grades of 3 Egyptian cotton varieties. He found significant positive correlation coefficients between lint grade and colour index which were 0.696, 0.691 and 0.967 for Giza 70, Giza 69 and Giza 72 varieties, respectively. Ahmed and Kamal (1981) proposed the equation : Percent reflectance (Rd %) X Micronaire reading/Non-lint content %, to calculate the so called "Grade Factor". They elucidated that highly significant positive correlation and regression coefficients were found between lint grade and the proposed grade factor. The values of correlation coefficients ranged from 0.983 to 0.996.

MATERIALS AND METHODS

The materials used in the present study included the 4 commercial Egyptian cotton varieties Giza 75, Giza 76, Giza 77 and Giza 80. According to the local practise in Egypt both Giza 75 and Giza 80 belong to the long staple category while Giza 76 and Giza 77 belong to the extra long staple class.

A range of lint cotton grades from Fully Fair (FF) to Good/Fully Good (G/FG), in increments of either 1/4 or 1/2 of a grade, was used from each of the aforementioned varieties. To facilitate statistical procedures, grades were

converted into a numerical code as follows :

Grade	Code	Grade	Code
FF	1	FGF-1/4	8
FF+1/4	2	FGF	9
FF/ GF	3	FGF+1/4	10
GF-1/4	4	FGF/ G	11
GF	5	G- 1/4	12
GF + 1/4	6	G	13
GF/FGF	7	G + 1/4	14
		G/ FG	15

The samples of grades and varieties involved in the present study were taken from the cotton crop of 1993 season. Each sample was represented by 6 replications.

The HVI system was utilized to determine colour attributes of Rd % and +b (ASTM, D- 2253-66), micronaire reading (ASTM, D- 1448- 59) and trash grade code (ASTM, D- 1451- 67). Trash grade is numbered 1 through 7 with each showing increasing trash level with the increase of code number. Listed below is the trash grade of white American cotton grades (USDA, 1984) :

Grade	Code	HVI Trash Grade
GM	(11)	1
SM	(21)	2
Mid	(31)	3
SLM	(41)	4
LM	(51)	5
SGO	(61)	6
GO	(71)	7
BG	(81)	8

Colour index was expressed as the ratio of colour brilliance (Rd %) to the degree of yellowness (+b), i.e. Rd/ +b. On the other hand the equation : Colour brilliance (Rd %) X micronaire reading / Trash grade code was used to derive the value of the "Grade Factor".

Measurements of the properties were accomplished at the laboratories of the Cotton Research Institute, Agricultural Research Centre at Giza, Egypt. Statistical procedures outlined by Little and Hills (1978) were employed to analyze the data obtained.

RESULTS AND DISCUSSION

The standpoint of the numerical quantification of cotton grade, using the instrumental measurements of the grade determining factors of colour, trash content and fiber maturity, is to secure reliability and accuracy of cotton quality specification. As a matter of fact, the utilization of the numerical values of colour index and grade factor could provide speed, simplicity and efficiency of the determination of cotton quality and grade with minimal reliance on classer's grade.

1- Relation of Fiber Maturity, Colour Attributes and Trash Content to Cotton Grade :

The data displayed in Table 1, denote that in all the 4 studied varieties, cotton fiber maturity, expressed in terms of micronaire reading, and colour brilliance (Rd %) tended to decrease progressively and consistently with the diminish of cotton grade, and hence their correlation coefficients (r) with grade were all positive and significant. By contrast, HVI trash grade values were found to increase evidently with lowering of the grade and this, in turn, was revealed by the negative and significant correlation coefficients between trash code and grade. As regards the relation of the degree of yellowness (+b) to cotton grade, it is of particular concern to note that this relation was negative in the white coloured varieties (Giza 75 and Giza 76), whereas it was positive in the creamy coloured varieties (Giza 77 and Giza 80).

The obvious decrease in fiber maturity with the decrease of cotton grade is ascribed to the well recognized fact that low grade cotton contains a high proportion of dead and poorly developed immature fibers produced by late formed bolls which are mostly damaged due to the action of insects and diseases. Further, plant senectitude along with the inadequate environmental conditions under which the late set bolls are developed and matured, are other factors with the potential for

Table 1. Average values of micronaire reading, colour brilliance (Rd %), degree of yellowness (+b), HVI trash grade code and their correlation coefficients (r) with lint grades.

Lint grade	Micronaire reading				Colour brilliance (Rd %)				Degree of yellowness (+b)				HVI trash grade			
	Giza 75	Giza 76	Giza 77	Giza 80	Giza 75	Giza 76	Giza 77	Giza 80	Giza 75	Giza 76	Giza 77	Giza 80	Giza 75	Giza 76	Giza 77	Giza 80
G/ FG	4.3	3.6	3.4	4.1	77.9	78.1	64.1	62.1	9.0	8.2	12.5	12.7	2.0	2.0	3.3	4.0
G + 1/4	4.0	3.6	3.3	3.8	77.0	75.2	63.8	61.1	8.5	8.5	12.3	12.0	3.0	3.0	3.7	4.0
G	3.9	3.5	3.2	3.6	73.0	74.7	62.9	58.0	8.4	8.6	12.1	12.1	4.0	3.0	4.0	4.3
G - 1/4	3.7	3.3	3.2	3.5	71.4	72.6	62.0	56.5	8.3	8.9	12.2	12.0	4.0	3.7	4.0	4.7
FGF/ G	3.4	3.2	3.1	3.3	68.2	70.1	59.5	56.1	8.8	8.8	11.9	11.7	4.7	4.0	5.0	5.0
FGF + 1/4	3.4	3.2	2.9	3.1	66.9	69.2	57.6	55.5	9.1	8.9	11.8	11.5	5.0	4.0	6.0	6.0
FGF	3.3	3.1	2.8	2.7	57.6	67.5	57.1	55.5	8.8	9.1	11.5	11.7	6.0	4.7	7.3	6.0
GF/ FGF	3.3	3.1	2.8	2.6	56.0	64.1	56.2	55.7	10.0	9.0	11.6	11.6	6.0	5.0	7.3	8.0
GF	3.4	3.0	2.7	2.5	55.5	63.8	55.0	55.6	10.3	9.1	11.1	11.6	7.3	5.0	8.0	8.0
FF/ GF	3.1	2.9	2.6	2.6	56.0	62.9	55.7	56.0	10.4	9.4	11.0	11.4	7.3	5.7	8.0	8.0
FF	3.1	2.9	2.6	2.6	55.6	62.6	54.1	55.0	10.9	9.9	11.0	11.5	8.0	6.0	8.0	8.0
$\bar{X}$	3.54	3.22	2.96	3.13	65.01	69.16	58.91	57.00	9.32	8.94	11.73	11.80	5.21	4.19	5.87	6.00
r	0.873**	0.942**	0.958**	0.903**	0.916**	0.955**	0.936**	0.728**	-0.916**	-0.941**	0.971**	0.792**	-0.971**	-0.963**	-0.933**	-0.946**

* = Significant at 0.05 level.

** = Significant 0.01 level.

contributing to a marked reduction in cotton fiber maturity of those late bolls which constitute the majority of low grade cotton. In this regard, *Lord (1981)*, stated that immaturity is not caused by premature death of the fibers, but it is a consequence of the poorer growth conditions including plant senescence.

The positive association between colour brilliance (Rd %) and cotton grade is attributable to the fact that low grade cotton contains high amount of trash residues and other contaminants along with black and yellow spots induced by the action of insects and diseases. Thus, the low grade cotton would lose its brightness and becomes duller and darker in colour. Lord (1961) supported this viewpoint where he stated that the clean high grades are the lightest in colour with the highest brilliance and the dirty low grades are darker with lower brilliance. He added that brilliance changes materially from the highest to the lowest grade largely because of the alteration in trash content and partly because of the small concomitant changes in the colour of the actual fibers.

The evident increase in trash content with lowering of cotton grade is due to the well known fact that the low grade cotton is ordinarily picked late when plant foliage including leaves, stems, bracts, hulls and bark would become dry and brittle. Thereupon, the dry particles could easily attach to seed cotton locks. In addition to plant foliage residues, low grade cotton also contains high amounts of sand, dust, motes and parts of crushed seeds.

The degree of yellowness (+b) and cotton grade were found to correlate positively in creamy coloured varieties and inversely in white coloured ones. These findings connotes that the high grades of creamy coloured cottons, i.e. Giza 77 and Giza 80, tended to contain more chroma than the low grades, while the reverse pattern was true with respect to the white coloured varieties, i.e. Giza 75 and Giza 76, where chroma was found to increase with lowering of the grade. However, Nickerson (1960) supported this finding where she referred to that measurements of the degree of yellowness (+b) may vary from 4 or 5 for some of the lower grade cottons to as much as 16 for a high grade yellow stained cotton.

2- Colour Index as a Numerical Indication of Lint Cotton Grade :

Colour index value is numerically calculated as the ratio of colour brilliance (Rd %)/ degree of yellowness (+b). Thus, the highest value of colour index would be attained from the highest value of brilliance (Rd %) combined with the lowest degree of yellowness (+b) and vice versa. However, it is rather interesting to note from table 2 that colour index was strongly and positively correlated with lint grade in the white coloured varieties Giza 75 and Giza 76, indicateing that colour index values decline with the diminish of cotton grade. Conversely, the correlation coefficients between colour index and lint grade were statistically insignificant in creamy coloured cotton varieties Giza 77 and Giza 80. Noteworthy is that in the white cottons, the range of colour index values was 4.0 (from 5.1 to 9.1) in Giza 75 and 3.2 (from 6.3 to 9.5) in Giza 76. As for the creamy cottons, the range of colour index was merely 0.4 in both studied varieties, i.e. from 4.8 to 5.2 in Giza 77 and from 4.7 to 5.1 in Giza 80. These results emphasize that there are distinct differences between the different grades of white coloured cotton varieties regarding their colour index values and obviously the higher grades with their high values of Rd % and low values of +b would have higher values of colour index than the lower grades. A rational explanation for the poor association between cotton grade and colour index in the creamy coloured varieties Giza 77 and Giza 80, is that cotton grade correlates positively with both colour brilliance (Rd %) and degree of yellowness (+b). This means that in high grades, the positive effect for the increase of Rd % value on enhancing cotton grade would be offest and masked by the corresponding increase in the value of +b. Likewise, in low grades, the decrease in Rd % is also accompained by a decrease in +b. The consequence of these impacts is that the values of colour index of either the high or the low cotton grades of the creamy coloured varieties would be close to each other and the differences between them would be eventually insignificant. In conclusion, colour index appears to be a sufficient criterion for defining the grade and quality of white coloured cotton types, while it seems to be not incisive and unreliable in case of the creamy coloured cotton varieties.

Listed below are proposed classes for rating and ranking the samples of white coloured cottons, in accordance with the values of colour index. The classes are ranked in succession starting with "A" for the highest class.

Table 2. Average of the derived values of colour index and grade factor along with their correlation coefficients (r) with lint cotton grades.

Lint grades	Colour index				Grade factor			
	Giza 75	Giza 76	Giza 77	Giza 80	Giza 75	Giza 76	Giza 77	Giza 80
G/ FG	8.6	9.5	5.1	4.9	167.5	140.6	66.0	63.6
G + 1/4	9.1	8.8	5.2	5.1	102.7	90.2	56.9	58.0
G	8.7	8.7	5.2	4.8	71.2	87.2	50.3	48.6
G - 1/4	8.6	8.2	5.1	4.7	66.0	64.8	49.6	42.1
FGF/ G	7.8	8.0	5.0	4.8	49.3	56.1	36.9	37.0
FGF + 1/4	7.4	7.8	4.9	4.8	45.5	55.4	27.8	28.7
FGF	6.5	7.4	5.0	4.7	31.7	44.5	21.9	25.0
GF/ FGF	5.6	7.1	4.8	4.8	30.8	39.7	21.6	18.1
GF	5.4	7.0	5.0	4.8	25.8	38.3	18.6	17.4
FF/ GF	5.4	6.7	5.1	4.9	23.8	32.0	18.1	18.2
FF	5.1	6.3	4.9	4.8	21.5	30.2	17.6	17.9
$\bar{X}$	7.11	7.77	5.03	4.83	57.80	61.73	35.03	34.05
r	0.949**	0.967**	0.543	0.231	0.794**	0.840**	0.895**	0.901**

** Significant at 0.01 level.

Class designation	Colour index values	Class designation	Colour index values
A	9.1 - or more	F	6.6 - 7.0
B	8.6 - 9.0	G	6.1 - 6.5
C	8.1 - 8.5	H	5.6 - 6.0
D	7.6 - 8.0	I	5.1 - 5.5
E	7.1 - 7.5	J	5.0 or below

It seems worthwhile to mention that some successive classer's grades of white coloured varieties would be included within the range of the same proposed colour index class indicating that those grades are in fact of comparable quality.

3- Grade Factor as a Numerical Indication of Lint Cotton Grade :

As it has been previously reported, grade factor value is calculated from the equation : Colour brilliance (Rd %) x Micronaire reading / Trash grade code. The presentation of the equation in this form denotes that in general, the highest value of the grade factor would be obtained from the maximal value of the numerator, i.e. Rd % and micronaire reading, along with the minimal value of the denumerator, i.e. trash grade code. Hence, it is understandable that the highest grade factor would be attained for the cotton having the highest colour brilliance (Rd %) coupled with the highest level of fiber maturity along with the lowest trash content. Conversely, the lowest grade factor value would be attained for the cotton with the lowest colour brilliance (Rd %), lowest fiber maturity and highest trash content.

The data recorded in table 2 reveal that, in all studied cotton varieties, there was an obvious downward trend in the values of the grade factor associated with lowering of the classer's grade. This was actually indicated by the highly significant positive correlation coefficients (r) obtained between lint cotton grade and grade factor. Accordingly, it could be stated that the lower the lint grade, the lower is the grade factor, considering that the low grade cotton has lower colour brilliance, lower fiber maturity and higher trash content and consequently it would have lower grade factor value and vice versa.

It is rather interesting to note that the same nominal lint cotton grades from

the different varieties included in the study were found to have distinctly different grade factor values irrespective of the category to which the varieties belong. For instance the two lint grades G/ FG and G + 1/4 of the long staple variety Giza 75 exhibited evidently higher values of grade factor than those of the same corresponding grades of the extra-long staple variety Giza 76 (Table 2). Further, the grade factor values of the same grades in both Giza 77 and Giza 80 varieties were generally comparable regardless of the fact that Giza 77 is an extra-long staple variety while Giza 80 is a long staple type. These findings are logically ascribed to that the different cotton varieties have inherently different colour attributes (brightness and yellowness), as well as different levels of fiber fineness and maturity (micronaire reading) and also the amount of trash contained in a given grade would differ according to the variety and growing location. However, these fimdings strongly assert the reality and crediblity of the statement of Lord (1961) who reported that grade in Egypt is not absolute but rather a comparative measure of quality among samples of the same variety.

It is worth mentioning that Ahmed and Kamal (1981), used the value of non-lint content %, instead of the HVI trash grade code, along with colour (Rd %) and micronaire reading, which were measured separately, to calculate the grade factor of various lint grades of 3 Egyptian cotton varieties, In fact, the apparent drawback of the use of non-lint content % in their study is that it was determined on the Shirley Analyzer which is a time-consuming process. In contrast, with the availability of HVI instruments, trash grade code is simultaneously determined with colour and micronaire reading and this in turn would provide speed, simplicity and practicality of determining the value of the grade factor.

Since the same nominal cotton grade from different varieties could have markedly different values of grade factor which coincide with its inhernet characteristics of colour, maturity and trash content, hence it is rational to report that each variety is supposed to have its own proposed grade factor classes. However, as examples, the following are the suggested grade factor classes of the two extra-long staple varieties Giza 76 and Giza 77.

Class designation	Grade factor values	
	Giza 76	Giza 77
A	131 - or more	61 - or more
B	111 - 130	51 - 60
C	91 - 110	41 - 50
D	71 - 90	31 - 40
E	51 - 70	21 - 30
F	31 - 50	11 - 20
G	30 or below	10 or below

Class A is, of course, the highest class and the others are progressively lower. It should be mentioned that the proposed class interval is 20 grade factor units for Giza 76 and only 10 units for Giza 77. This is due to the fact that the range of grade factor values of Giza 76 was evidently greater than of that Giza 77. As for any other varieties the same conception could be applied.

It is of particular concern to note that several consecutive cotton grades will be included under the range of the same grade factor proposed class. A similar pattern was reported with respect to colour index classes. These findings imply that a difference of 1/4 or even 1/2 of a classer's grade is not reliable and hence, those concerned grades are in fact of comparable quality and most likely they would have similar processing efficiency and performance in spinning and virtually their end products will be of restricted quality variation.

In conclusion, the grade factor appears to be an elaborate and credible numerical means that could be used satisfactorily to define and specify the grade and quality of cotton without much reliance on classer's grade. In fact classer's grade is mostly subjected to a great deal of contravention and inconsistency due to human bias and also due to the insufficiency of the conventional grading procedure per se, since it is entirely qualitative.

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تقدير رتبه الشعر بصوره رقميه في القطن المصري

مصطفي محمد كمال ، ماهر طلعت رجب

معهد بحوث القطن – مركز البحوث الزراعيه – الجيزة

استخدم في هذه الدراسه صنفي القطن المصري جيزه ٧٥ ، جيزه ٨٠ من طبقه الأقطان الطويله التيله الأقطان وكذلك الصنفان جيزه ٧٦ ، جيزه ٧٧ من طبقه الأقطان الطويله التيله الممتازه بالأضافه إلي ذلك استخدم من كل صنف مدي من رتب القطن الشعر يتراوح بين رتبتي فولي فير وجود / فولي جود ، وكانت الفروق بين كل رتبه والتي تليها ١/٤ أو ١/٢ رتبه .

وقد أستخدمت قيم دليل اللون Colour index ومعامل الرتبه Grade factor للإشاره إلي رتبه القطن بصوره رقميه وذلك لتوفير مزيد من الدقه والمصداقيه لعمليه تحديد جوده القطن . وقد أشارت نتائج الدراسه إلي أن قيم دليل اللون كانت ترتبط ارتباطا قويا وموجبا مع رتبه الشعر وذلك في أصناف القطن ذات اللون الأبيض وهي جيزه ٧٥ ، وجيزه ٧٦ . اما في الأقطان ذات اللون الكريمي وهي جيزه ٧٧ ، جيزه ٨٠ ، فقد كان هذا الأرتباط غير معنوي ، ومن ناحيه أخري فقد وجد أن معامل الرتبه يرتبط ارتباطا موجبا ومعنويا مع رتبه الشعر وذلك في جميع أصناف القطن الأربعه المستخدمه في الدراسه . وبناء عليه يمكن القول بأن معامل الرتبه هو وسيله رقميه موثوق بها يمكن استخدامها للتعبير عن رتبه القطن وجودته بدون الأعتماد كثيرا علي رتبه الفراز التي غالبا ما تكون عرضه للتناقض والتضارب حيث أنها وسيله وصفيه تماما لتحديد رتبه القطن وجودته .