Egypt. J. Agric. Res., 77 (4), 1999.

COLOR AS A CRITERION OF CHARACTERIZATION AND IDENTIFICATION OF EGYPTIAN COTTON VARIETIES

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(Manuscript received 5 October, 1998)

Abstract

The present study was designed and undertaken to define color attributes of lightness or brilliance (Rd%) and chroma or degree of yellowness (+b) of the Egyptian cotton varieties. The objective is to determine the variation and the confidence limits within which the intrinsic inherent color attributes of each of the Egyptian cotton varieties would vary . As such , color attributes could be regarded as reliable criteria utilized to characterize and to identify cotton varieties.

The materials used in the present study comprised 12 Egyptian cotton varieties, grown in 1997 season , which are classified according to the local practice in Egypt as either Extra-Long staple or Long staple. Those varieties were grown at different locations in Delta (North) and Upper Egypt (South). The samples representing the cotton varieties involved in the study were found to have lint grades ranging between Good -1/4 and Good + 1/4.

In virtue of the color attribute of degree of yellowness (+b) , the commercial Egyptian cotton varieties were classified into 2 color categories i.e. White and Creamy., each including 3 color classes,i.e. Extra-white, Light White and White in the White color category and Light Creamy, Creamy and Dark Creamy in the Creamy color category. Further. the confidence limits for the values of color attributes of lightness and yellowness of the Egyptian cotton varieties, were determined. Those confidence limits could be used to define the identity of a cotton sample with a specified confidence of 95% in accordance with the coincidence or divergence of the values of color attributes of the concerned sample relative to the values of the confidence limits of a given variety.

INTRODUCTION

Color of cotton is an important quality consideration which is in principle a varietal characteristic determined by the genotype; yet it is affected by the environmental conditions which would induce varying extents of discoloration. Concerning the intrinsic inherent color of cotton, it is acknowledged that white and creamy colors are the commonest and the most prevalent in the commercial cottons in the world. The American Upland cotton has a bright white color , while the Sea Island cotton is usually of a creamier color than Upland cotton (Baily,1954). Further, the

Pima cotton is more creamy in color by several shades than both the Upland and Sea Island cottons. However, Ware and Benedict (1962) stated that cotton plants producing lint of various shades of brown color have occurred occasionally in the different commercial cottons of the world throughout the long period of their culture. Green lint likewise has been reported only in the Upland cottons. Those colored cottons arose from spontaneous reverse mutant plants or were developed from relic stocks carried over in the crops of white cotton from a more primitive state of the species. Rollins (1965), pointed out that the tints of highly colored cottons range from deep caramel to khaki to beige, while the green cottons have olive color which fades to tan on exposure to sunlight.

Cotton which is picked promptly after boll opening has a bright color since it would not be liable to environmental effects pertaining to edaphic, climatic and biological factors. Those factors are with the potential for inducing discoloration of cotton. The extent of discoloration has a significant impact on cotton quality expressed in terms of grade. In general, any departure from the bright color of normally opened cotton indicates an inferiority of quality. However, Nickerson (1951), stated that if cotton is left in the field for a sufficient length of time under unfavorable weather conditios, its grade will be low either by darkening in color or by becoming gray or tinged or even blue or yellow stained. Simon and Harmon (1954), ascribed change in cotton color directly to microbial action where they reported that samples of cotton after 12 weeks of weathering were found to contain fungi; largely Alternaria, Cladosporium and Fusarium, while the unweathered samples were relatively free from fungi. Marsh *et al.* (1958) referred to that darkening or graying in color of cotton fibers takes place during humid preharvest weathering and this darkening is a strong determinant of grade. Lord. (1961), pointed out that leaving the cotton unpicked in the field for a long time causes it to become duller and darker in color. 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 small concomitant changes in the color of the actual fibers. The clean high grades are the lightest with the highest brilliance and the dirty low grades are darker with lower brilliance. Kamal *et al.* (1987) reported that the role of color brilliance expressed in terms of percent reflectance (Rd%) as a determinant of cotton grade was much superior to that of chroma or degree of yellowness (+b) .

Color uniformity of a commercial cotton variety is extremely important and should be maintained by all means to ensure genetic purity and to steer clear of any possible deterioration in cotton fiber quality. The fact of matter is that lack of color

homogeny is regarded as a warning sign indicating that the cotton variety is likely to be genetically impure. However, it is of particular concern to mention that homogeneous color is an essental requirement in commercial transactions in world cotton market. Thus, to sustain the unique reputation of the Egyptian cotton in the world market , color uniformity of the commercial varieties should be strictly secured.

MATERIALS AND METHODS

The materials used to carry out the present study comprised 12 Egyptian cotton varieties which were in commercial cultivation in 1997 season. Those varieties are classified according to the local practice in Egypt as either Extra- Long Staple (ELS) or Long Staple (L.S). The Extra-Long Staple varieties used were Giza 45,Giza 70, Giza76, Giza 77, Giza 87 and Giza 88, while the Long Staple types were Giza 75, Giza 80, Giza 83, Giza 85, Giza 86, and Giza 89. Lint cotton samples representing the aforementioned varieties were taken from the preliminary (A) and advanced (B) yield trials conducted by the Cotton Breeding Research Section of the Cotton Research Institute in Egypt. Those yield trials were carried out at different growing locations in Dalta (North)and Upper Egypt (South). The samples of all the varieties involved in this study were calssified by grade and found to have lint grades ranging between Good -1/4 and Good +1/4. Color attributes of lightness or brilliance (Rd%) and chroma or degree of yellowness (+b) of the cotton samples were measured on the Colorimeter of the HVI system according to the standard test method of the American Society for Testing and Materials-ASTM (1967); Designation, D- 2253-66. The classification for grade and the measurements of color attributes of the cotton samples of the study were conducted at the laboratories of the Cotton Grading Research Section, Cotton Research Institute, Agricultural Research Centre ; Giza, Egypt.

Statistical parameters of the data of color measurements of the cotton varieties included in the study were calculated in accordance with the procedures outlined by Little and Hills (1978).

RESULTS AND DISCUSSION

1. Color attributes of the commercial Egyptian varieties:

The data of table 1 reveal that, with regard to the Extra- Long Staple (ELS)

Egyptian cotton varieties, Giza 76 variety proved to have, on average, the highest degree of lightness or brilliance (Rd%) along with the least degree of chroma or yellowness (+b) . In contrast, Giza 88 variety was found to have the least degree of lightness associated with the highest degree of yellowness. with respect to the Long Staple (LS) varieties (Table2),Giza 75 was the variety with the highest color lightness, whereas the reverse was true as for Giza 80, where it was the variety with the least lightness. Further, the same variety, i.e. Giza 80 attained the highest value of yellowness, while Giza 89 was the variety having the least degree of yellowness. However it is worthy to mention that the varietal differences in the intrinsic color, which is genetically controlled, are essentially determined by the degree of yellowness (+b) rather than being determined by the degree of lightness (Rd%). In this respect, Kamal *et al.* (1990) referred to that chroma or yellowness was the major criterion determining the color differences between the color classes of Egyptian cotton, while lightness did not seem to have an outstanding role in this respect. Accordingly, considering the overall data of yellowness values (+b) of the present study (Tables 1 and 2), it could be generally stated that , among the commercial Egyptian cotton varieties , Giza 80 is the variety that has the highest degree of yellowness and hence the least degree of whiteness. Conversely, Giza 89 variety is the whitest having the least degree of yellowness.

Color attributes of lightness or brilliance (Rd %) and chroma or degree of yellowness (+b) were found to vary within each of the studied varieties grown at different locations. The magnitude of variation differed among the varieties indicating diverse response to environmental effects and hence different genotype x environment interactions. This conclusion is obvious from the data of the measures of dispersion displayed in table 3 , i.e. range, standard deviation (SD), standard error (SE) and coefficient of variation (C.V.%). Nevertheless, in conformity with the values of C.V.%, it could be stated that the most variation in the values of color lightness or brilliance (Rd%) was recorded for Giza 85 variety grown in Upper Egypt trials, while the least variation in this regard was that within Giza 45 variety. Likewise, Giza 85 of Upper Egypt also revealed the widest variation in the degree of yellowness (+b), whereas Giza 88 variety attained the least variation in yellowness values.

2. Characterization of the Egyptian cotton varieties in conformity with their color attributes :

Besides the color attributes of lightness or brilliance (Rd%) and chroma or

Table 1. Color attributes of lightness or brilliance (Rd%) and chroma or degree of yellowness (+b) of the Extra-Long Staple (ELS) Egyptian cotton varieties grown on yield trials (A&B) at different locations in Delta.

Growing location	Lightness or brilliance (Rd %)						Chroma or degree of yellowness (+b)					
	Giza 45	Giza 70	Giza 76	Giza 77	Giza 87	Giza 88	Giza 45	Giza 70	Giza 76	Giza 77	Giza 87	Giza 88
1- Sakha (A)	69.6	66.4	69.8	61.6	71.2	62.9	9.7	9.5	9.1	11.4	9.0	12.0
2- Sakha (B)	70.7	68.7	70.2	62.8	69.5	63.3	9.2	9.1	9.3	11.2	9.2	11.7
3-Kafr Saad (B)	71.9	70.4	72.1	65.5	72.0	64.0	9.4	8.6	8.4	11.9	8.8	11.5
4- Al-Safasief (B)	71.6	70.6	74.9	65.4	73.3	64.1	9.5	9.4	8.8	11.7	8.9	11.8
5- Tanta (B)	72.0	74.4	74.4	64.9	72.4	65.3	9.4	9.0	9.0	11.5	8.9	11.6
6- Al-Shohada (B)	71.6	69.9	72.7	65.4	71.3	63.1	8.8	9.3	8.7	11.2	9.0	11.5
7- Meet Ghamr (B)	72.0	73.9	72.0	64.7	71.5	65.5	9.6	9.4	8.9	12.0	9.2	11.9
8- Menya El Kamh (B)	70.7	68.7	70.2	62.8	69.5	63.3	9.2	9.1	9.3	11.2	9.2	11.7
Mean ($\bar{x}$)	71.26	70.38	72.04	64.14	71.34	63.94	9.35	9.18	8.94	11.51	9.02	11.71

Table 2. Color attributes of lightness or brilliance (Rd%) and chroma or degree of yellowness (+b) of the Long Staple Egyptian cotton varieties (LS) grown on yield trials (A&B) at different locations in Delta and Upper Egypt.

Delta varieties									Upper Egypt varieties						
Growing location	Lightness or brilliance (Rd %)				Chroma or degree of yellowness (+b)				Growing Locations	Lightness or brilliance (Rd %)			Chroma or degree of yellowness (+b)		
	Giza 75	Giza 85	Giza 86	Giza 89	Giza 75	Giza 85	Giza 86	Giza 89		Giza 80	Giza 83	Gzia 85	Giza 80	Giza 83	Giza 85
1- Sakha (A-1)	71.8	74.0	74.2	71.9	8.8	8.8	8.7	7.8	1- Al-Giza (A)	65.2	67.2	71.7	12.1	11.0	9.1
2- Sakha (A-2)	72.0	70.4	74.0	70.9	9.0	8.7	9.3	8.1	2- Sids (A)	58.7	61.7	68.4	13.0	11.5	10.1
3- Sakha (B)	72.7	67.4	72.8	72.0	8.7	8.9	9.6	8.0	3- Al- Giza (B)	61.8	66.5	71.3	12.5	11.6	9.5
4-Kafr Saad (B)	71.8	74.1	72.7	67.1	8.7	9.3	8.7	8.3	4- Al- Fayoum (B)	65.2	68.9	76.1	12.2	11.2	8.5
5- Damanhour(B)	75.6	74.3	72.3	74.2	8.9	9.1	8.7	7.7	5- Sids (B)	60.3	66.1	68.5	12.7	10.6	9.5
6- Tanta (B)	72.9	71.0	73.4	72.4	8.5	9.2	8.5	7.8	6- Maghagha (B)	60.5	64.0	70.2	12.9	10.7	9.0
7- Al-Shohada (B)	73.3	69.6	70.1	69.4	9.4	9.4	8.9	8.3	7- Asyout (B)	63.2	62.9	67.8	12.9	11.2	8.9
8- Meet Ghamr (B)	67.8	70.7	70.7	71.4	9.0	9.4	9.1	8.2	8- Sohag (B)	62.2	66.6	69.9	12.8	10.7	8.5
9-Menya El Kamh (B)	73.4	64.8	65.3	68.9	8.8	10.2	9.8	8.2	9- Al-Matanaa (B)	58.4	64.8	64.0	12.9	11.6	9.6
Mean (X)	72.37	70.70	71.72	70.91	8.87	9.22	9.03	8.04		61.72	65.41	69.77	12.67	11.12	9.19

* Giza 85 variety is grown in both Delta and Upper Egypt yield trials.

degree of yellowness (+b), color in general also requires a third description which is the hue. Lord (1961) referred to that hue may be defined as the name of the color, for instance, yellow, blue, red, etc. As for the American Upland cotton , there are 5 recognized color classes, i.e.; White, Light Spotted, Spotted, Tinged and Yellow Stained. Chroma or yellowness mainly determines the differences between the major color classes, modified slightly by the brilliance according to the amount of foreign matter present. Yellowness Steadily increases through the White, Spotted, Tinged to the Yellow Stained class. (Lord,1961). Further, the findings of Kamal *et al.* (1990) clearly indicated that chroma or yellowness was the major criterion determining the color differences between the color classes of the Egyptian cotton, while lightness did not seem to have an outstanding role in this respect.

Accordingly, it appears rational to consider the color attribute of chroma or yellowness (+b) as the basis upon which the commercial Egyptian cotton varieties are characterized by virtue of their intrinsic color. Thereupon, those varieties are broadly classified into 2 basic color categories, i.e. White and Creamy. For finer distinction, each color category is divided into 3 color classes, i.e. the White color category is divided into the 3 distinct classes of Extra-White, Light White and White. The conception of this classification is that there are some differences in the degree of whiteness between the 3 aforementioned color classes which could be visually detected. This implies that the Extra-White class would have the highest degree of whiteness and thus the least degree of yellowness, while the 2 other classes are progressively lower in whiteness and hence higher in yellowness. This connotes that the Light White class is whiter in color than the white class. Likewise, the Creamy color category is proposed to be divided according to the degree of yellowness into the 3 color classes of Light Creamy, Creamy and Dark Creamy. Yellowness, however, would increase progressively through those classes respectively;meaning that the Light Creamy class is the one with the least degree of yellowness and the Dark Creamy class would have the highest intensity of yellowness.

As such, it is suggested to classify the commercial Egyptian cotton varieties, in virtue of the mean values ($\bar{x}$) of their color attribute of yellowness (+b) reported in table 3, as shown in the following tabulation:

Table 3. Statistical parameters of range, mean ($\bar{x}$), standard deviation (S.D.), standard error (S.E.), coefficient of variation (C.V.%) and confidence limits (C.L.) of color attributes of lightness or brilliance (Rd %) and chroma or degree of yellowness (+b) of the commercial Egyptian cotton varieties.

Cotton varieties	Lightness or brilliance (Rd %)						Chroma or degree of yellowness (+b)					
	Range	$\bar{x}$	S.D.	S.E.	C.V.%	C.L.	Range	$\bar{x}$	S.D.	S.E.	C.V.%	C.L.
Extra-Long Staple												
1- Giza 45	69.6-72.0	71.26	0.86	0.30	1.2	70.55-71.97	8.8-9.7	9.35	0.28	0.10	3.0	9.11-9.59
2- Giza 70	66.4-74.4	70.38	2.68	0.95	3.8	68.13-72.63	8.6-9.5	9.18	0.29	0.10	3.2	8.94-9.42
3- Giza 76	69.8-74.9	72.04	1.93	0.68	2.7	70.43-73.65	8.4-9.3	8.94	0.31	0.11	3.5	8.68-9.20
4- Giza 77	61.6-65.5	64.14	1.51	0.53	2.4	62.89-65.39	11.2-12.0	11.51	0.32	0.11	2.8	11.25-11.77
5- Giza 87	69.5-73.3	71.34	1.32	0.47	1.8	70.23-72.45	8.8-9.2	9.02	0.16	0.06	1.8	8.88-9.16
6- Giza 88	62.9-65.5	63.94	0.99	0.35	1.5	63.11-64.77	11.5-12.0	11.71	0.18	0.06	1.5	11.57-11.85
Long Staple												
1- Giza 75	67.8-75.6	72.37	2.07	0.69	2.9	70.78-73.96	8.5-9.4	8.87	0.25	0.08	2.8	8.69-9.05
2- Giza 80	58.4-65.2	61.72	2.51	0.84	4.1	59.78-63.66	12.1-13.0	12.67	0.33	0.11	2.6	12.42-12.92
3- Giza 83	61.7-68.9	65.41	2.26	0.75	3.4	63.68-67.14	10.6-11.6	11.12	0.40	0.13	3.6	10.82-11.42
4- Giza 85 (a)	64.8-74.3	70.70	3.21	1.07	4.5	68.23-73.17	8.7-10.2	9.22	0.45	0.15	4.9	8.88-9.56
5- Giza 85 (b)	64.0-76.1	69.77	3.30	1.10	4.7	67.23-72.31	8.5-10.1	9.19	0.53	0.18	5.8	8.77-9.61
6- Giza 86	65.3-74.2	71.72	2.77	0.92	3.9	69.60-73.84	8.5-9.8	9.03	0.45	0.15	5.0	8.69-9.37
7- Giza 89	67.1-74.2	70.91	2.13	0.71	3.0	69.27-72.55	7.7-8.3	8.04	0.23	0.08	2.9	7.86-8.22

* Giza 85 (a) is grown in trials in Delta and Giza 85 (b) is grown in trials in Upper Egypt.

Table 4. Color categories and color classes of the Egyptian cotton varieties :

Color Color category	Characterization Color class	Yellowness (+b) values	Varieties
White	Extra White	Less than 9.00	Giza 76, Giza 75 and Giza 89
	Light White	9.00 -< 9.90	Giza 45, Giza 70, Giza 87, Giza 85 and Giza 86
	White	9.90 -< 10.80	————
Creamy	Light Creamy	10.80 -< 11.70	Giza 77 and Giza 83
	Creamy	11.70 -< 12.60	Giza 88
	Dark Creamy	12.60 or more	Giza 80

It is of particular concern to note that it has deemed appropriate to use a class interval of 0.9 yellowness value (+b) to specify the range of yellowness within each of the foregoing color classes.

3-Identification of cotton by virtue of its color attributes:

Despite the fact that color of cotton is predominately a varietal character which is genetically controlled, yet discoloration, could be developed in cotton due to the effect of environment which comprises edaphic, climatic and biological factors. Thus, the intrinsic inherent color of a cotton variety would vary to various extents due to environmental conditions; but this variation would be eventually within the limits set by heredity provided that the variety remains genetically pure. Nevertheless, it seems important to determine statistically, the confidence limits and hence the acceptable range within which the inherent color attributes of each of the commercial Egyptian cotton varieties would vary. However, in table 3, the confidence limits of the values of lightness or brilliance (Rd%) and chroma or degree of yellowness (+b) of the Egyptian cotton varieties, are shown. Those values of confidence limits could be used in identification of a cotton sample by judging whether or not a samlpe belongs to a given variety with a specified confidence of 95%. If the color attributes of the concerned sample fall within the confidence limits of that given variety, it could be stated that , with a confidence of 95% the sample represents that variety. Conversely, if the color values of Rd% and +b of the sample are out of the confidence limits, there would be doubts concerning the identity of the sample under investigation. The practical significance of this concept is that extent of coincidence or divergence of the values of color attributes, relative to the values within the confidence limits, would determine the extent of color uniformity and hence the ge-

netic purity of a cotton variety and would also reveal any possible mixing with other varieties particularly if those varieties are distinctly different in color .

It is worthwhile to clarify that color measurements of lightness (Rd%) and yellowness (+b) of the cotton varieties involved in the present study were made on samples having lint grades ranging between Good - 1/4 and Good + 1/4 . The grades falling within this range are those of the most frequent occurrence and thus they represent the majority of the commercial crop of any cotton variety . However, it is rather interesting to mention that any marked change in cotton grade , above or below the previously mentioned range, would bring about changes in the values of the color attribute of lightness or brilliance (Rd%) in particular, since yellowness (+b) is not obviously related to the grade of cotton (Kamal *et al.*, 1987). As such, it seems conceivable to state that our conclusion in this study is generally confined to the range of grades used in the present investigation, i.e. from Good -1/4 to Good +1/4.

Another point of significant interest is that values of range of the degree of yellowness (+b) of the different cotton varieties included in this study (Table 3), clearly indicate that it is very likely that the inherent color of a cotton variety would vary within the same color category,i.e. among the color classes of the same category, due to environmental effects. However , in accordance with the color classification reported in table 4, the color of Giza 87 variety, for instance, varies from Extra White (+b=8.8) to Light White (+b=9.2) as shown in Table 3, while Giza 88, for instance, has a color varying from Light Creamy (+b=11.5) to Creamy (+b=12.0). This pattern is true for all the varieties involved in the study with the exception of Giza 83 variety which was found to have inherent color varying in a wide range extending over 2 color categories; from White (+b=10.6) to Light Creamy (+b=11.6). The fact of matter is that it does not seem rational and not acceptable that a commercial cotton variety would have such a wide variation in color since this would raise suspicions regarding its genetic purity.

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اللون كمعيار لتوصيف وللتعرف علي أصناف القطن المصرى

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أجريت هذه الدارسة لقياس درجة إشراق اللون معبرا عنها بنسبة الإنعكاس(Rd %) ودرجة اصفرار اللون (+b) لاصناف القطن المصرى التجارية. وكان الهدف من ذلك تحديد التباين وحدود الثقة التى تتفاوت فيها خصائص اللون الذاتيه التي يحكمها التركيب الوراثى وذلك لكل صنف من اصناف القطن المصرى بحيث يمكن اتخاذ خصائص اللون هذه كمعايير يعول عليها لتوصيف وللتعرف علي تلك الاصناف .

وقد استخدم في الدراسة ١٢ صنف من اصناف القطن المصرى المنزرعة كاصناف تجارية فى موسم ١٩٩٧ والتى تصنف طبقا للعرف السائد في مصر اما كاصناف فائقة الطول (الطويلة التيلة الممتازة) او اصناف طويلة التيلة . وقد زرعت هذه الاصناف فى تجارب اجريت في عديد من مناطق الزراعة في شمال وجنوب مصر . وكانت العينات الماخوذة من تلك التجارب لاستخدامها في الدراسة تتراوح رتبة الشعر لها ما بين جود - ١/٤ وجود + ١/٤ .

وبناء على قيم درجة اصفرار اللون (+b) تم تصنيف اصناف القطن المصرى التجارية تبعا للونها الذاتى وادراجها تحت طبقتين من اللون هما الابيض والكريمى وتم تقسيم كل طبقة الي ثلاثة اقسام لونية هي فائق البياض والابيض الزاهى والابيض بالنسبه لطبقه الون الابيض والكريمى الفاتح والكريمي والكريمى الغامق لطبقه اللون الكريمى . وتم ايضا تحديد حدود الثقة لقيم درجه اشراق اللون (Rd %) ودرجة الاصفرار (+b) لكل صنف من اصناف القطن المصرى التجارية . وبناء على حدود الثقة لخصائص اللون يمكن تحديد هوية عينة ما من القطن وتحديد ما اذا كانت تتبع صنف معين وذلك بمستوى ثقه معين هو ٩٥٪وذلك على اساس وقوع متوسطات قراءات اللون لهذه العينة في داخل حدود الثقة او خارجها .