A STUDY OF
THE INHERITANCE OF LINT COLOUR IN CROSSES BETWEEN EGYPTIAN VARIETIES OF COTTON

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The colour of raw cotton is chiefly determined by the colouring matter termed as endochrome, in the contents of the hair lumen.

Harland (1939), stated that lint colour may be white, creamy white, dirty grey, various shades of brown up to almost a mahogany red, khaki, or bright green which speedily fades to a greenish rusty brown. Brown cottons of various shades exist in the Old World group and in the New World cottons; brown lint is represented in all species. Upland (G. hirsutum), Bourbon (G. purpurascens)* and Peruvian (G. barbadense) may have brown or white lint, while G. tomentosum, G. taitense, and G. darwinii always have brown lint. He also reported the presence of green lint in Upland cottons (G. hirsutum).

Ware and Benedict (1962), reported that coloured forms arise from spontaneous reverse-mutant plants or are developed from relic stocks carried over in the crops of white cotton from more primitive types. Evidence indicates that the prototypes of the modern varieties had coloured lint, and that commercial cottons of today began as white mutants from the native coloured cottons. All wild cottons

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* Included now under G. barbadense (Hutchinson et al. 1947).

existing at present, although they do not have true lint, yet they have highly coloured rudimentary fibres. In modern culture, the white mutants have been more progressive and subject to greater improvements than the progenitorial coloured forms, and consequently are much more useful. Under the protection and propagation, the white mutant derivatives rapidly multiplied and were ameliorated in new and varied conditions. Consequently, these cottons have spread and thrived profusely in the present cotton-growing countries. The commercial cottons of the world are white, with the exception of some tans and relatively light brown colour in some groups. These colours, which occur in most Egyptian cottons and in some Sea Island varieties, appear not to be associated with lowered yield and quality. The deep colours on the other hand, especially those in Upland cottons, seem to be associated with pleiotropic effects that depress yield and quality responses, and even alter some other expressions.

In U.A.R., an offtype plant of brown lint, known afterwards as Enan's Brown, was first observed in 1888 in a cotton field in Sharqia Province. Later on, this type was observed in the same Province in 1914, and was described and purified by Hussein Eman in 1920 (Helmy, 1949). Its lint is of deep brown to almost red colour, with small seed and very low lint percentage, yet it is a typical Egyptian plant with no resemblance to other cotton species which have lint of similar colour. In recent years, this mutation was observed in other cotton varieties; e.g., Karnak and Giza 45. Balls (1908 b), suggested that certain brown cottons were imported in the early years of the 19th century from Brazil with Sea Island origin and were crossed with the local Egyptian varieties.

In general, Egyptian cotton varieties are not white in colour, and their distinct creamy colour of lint became synonymous with Egyptian cottons. In the last century, some white cottons were introduced in Egypt, e.g., Abiad, Hamouli, Zafiri and Abbasi. These varieties disappeared after the introduction of Sakel which gave a high increase in the production of Egyptian cotton, although its lint was dark in colour. During this century, Casuli, Giza 7 and Sakha 4 had played an important role in the pedigree of our modern white varieties as reported by Gaffar (1955). Recently, some white varieties of Egyptian cotton were produced, notably the extra-long staple cotton Giza 45 and the medium long staple cotton Giza 69. Such cottons are highly welcomed by spinners as they need no bleaching before dyeing.

Lint colour is becoming an important property in the cotton industry and attracts an increasing interest. In the knitting industry, in particular, the colour of the raw material is important and valuable in varietal identification and grading. Homogeneity of colour is a practical criterion for judging the purity of commercial varieties. Thus, uniformity of lint colour is one of the main objects of cotton breeders in Egypt and in other cotton producing countries. Lack of colour uniformity was responsible for market rejection of some Egyptian cotton varieties in spite of their merits as Giza 59.

The naturally deep-coloured cottons have been put to two distinct uses. The first is to be used as gene markers in genetic studies, and the second in producing coloured textiles directly without dyeing.

This research was conducted principally to study the nature of inheritance of lint colour in Egyptian cottons, and to detect to what extent this colour is associated with inferior or superior properties. Since the inheritance of lint colour was previously studied on the basis of visual colour grades which varied according to personal judgement, lint colour was determined accurately in this study through the use of the modern Leukometer apparatus. Colour associations, either simple or genetic, with other characters as lint percentage, seed index, lint index and lint length were also studied. Such findings should help in the breeding of varieties of uniform colour and in avoiding the lint colour variability in commercial varieties.

The materials used were two intervarietal _barbadense_ crosses between each of the two white Egyptian cotton varieties, Giza 45 and Giza 69, and Brown Karnak, a deep brown almost red mutation isolated from Karnak fields.

II. REVIEW OF LITERATURE

a- Determination of Lint Colour :

The principal properties and characteristics of cotton lint which affect its quality, are mainly its grade, length and strength. The grade depends on three factors; colour, presence of leaf and other impurities, and ginning property. Colour, according to Nickerson (1950), may be described in terms of three attributes; hue, value and chroma. Hue is the name of the colour, value is the lightness or darkness of the colour, and chroma is the intensity, strength, or degree of colour, the last of which is considered the most important attribute.

In all the early studies of lint colour, the evaluation depended only on visual judgement. Recent development of instruments for measuring colour enabled technicians to analyse the colour components, i.e., hue, value and chroma. Johnson (1956) reported that the luster meter measures light reflectance from cotton fibres when arranged parallel in a bundle. Light reflectance is the measure of lint luster. Balls (1915) considered that lint luster is no more than simple reflection of light. He believed that lint luster is commonly thought to be due to variations in the reflection of light from different parts of the cuticularised walls of the exposed fibres. The Nickerson Hunter Cotton Colorimeter deviced by Nickerson (1950), is the most popular instrument for measuring colour of cotton samples, and gives the three colour attributes. Reflectance and colour are expressed in algebraic terms and by means of a chart. The plotted colour values of the sample may be compared with colour in the standard grades. The instrument is used to make subtle colour distinctions that are not always clearly perceived by the classer. It also serves to confirm or adjust the classer's judgment of the grade and colour of the sample. Fibre colour is recorded as R_d (reflectance) and +b (yellowness). White colours give high R_d and less +b readings.

Recently, research workers at Carl Zeiss Jena, designed an apparatus operating on the photo-electric principle, the so-called "Leukometer". This instrument determines numerically the differences in the degree of reflection between substances that are usually described as white. This means, that the Leukometer gives only the chroma or the percentage of whiteness.

b- Inheritance of Lint Colour :

The inheritance of lint colour has been studied by several workers. These studies included both Asiatic and New World cottons as well as interspecific crosses between Upland varieties (*G. hirsutum*) and Egyptian varieties (*G. barbadense*).

Balls (1906 & 1908 a), studying lint colour in crosses between two Egyptian varieties with coloured lint and white lint, considered that these two characters are allelomorphic pair of characters in cotton hybrids which exhibit complete dominance of coloured lint over white. Later on, the same author in (1912), studied the inheritance of lint colours in interspecific crosses between brown-linted Egyptian varieties and white-linted Uplands. He obtained intermediate F_1 populations of creamy colour and a simple ratio of 1 : 2 : 1 in F_2 as (12 : 21 : 11). One of these crosses, included Charara (very light brown Egyptian variety) x King (white Upland variety), gave an intermediate F_1 as shown before, but different distribution in F_2 such as; 9 brownish : 60 creamy : 109 white. This indicates that he did not get a simple segregation for lint colour in the F_2 generation of Egyptian x Upland hybrids.

Thadani (1923), reported that yellow or yellowish brown and white colours of cotton lint seemed to be allelomorphic in Upland varieties. He also studied linkage between certain characters, and found in one of these studies a linkage between naked seed factor (A) and abundant lint factor (B), while the lint colour factor (C) from Texas Rust variety was independent of (A and B) factors.

Kearney (1923), studied the inheritance of lint colour in an interspecific cross between the Holdon variety of Upland cotton (G. hirsutum) with white lint, and the Pima variety of American Egyptian cotton (G. barbadense) with pale buff lint. The F_1 lint was intermediate in colour between those of the two parents, while the F_2 generation showed a unimodal frequency curve. No definite ratios could be ascertained in F_2 generation of this cross, where the inheritance of lint colour seemed to be of the blending type.

In Texas it was reported that inheritance of lint colour appeared to be monofactorial, (Anonymous , 1927).

Brown (1927), in crossing two Upland varieties, the white Cleveland and the brown so-called Nankeen, obtained an intermediate F_1 of creamy hue, and a simple (1 : 2 : 1) ratio for lint colour in F_2 generation.

Ware (1928), showed that when two Upland varieties, Algerian brown lint and Argentine green lint, were crossed respectively with white-linted Upland varieties, the F_1 was intermediate between the colours of the two parents, and the F_2 segregated in (1 : 2 : 1) ratio. Later on, Ware (1932), crossed four Upland varieties having four different shades of lint colour, three were of brown lint and one was of green lint. Each variety was crossed with its white allelomorph. He found that the F_1 was an intergrade between that of the respective coloured parent and the white parent, indicating that lint colour was incompletely dominant over white. In the F_2 generation the crosses segregated into three classes in a (1 : 2 : 1) ratio.

Aboul-Ela (1930), was the first to study the inheritance of lint colour in Egyptian cotton(G.barbadense). He stated that lint colour of the Egyptian cotton varieties varied from nearly white to light brown. The Enan's brown cotton was distinctly brown or nearly red brown. He studied lint colour in two crosses including Enan's brown; the first cross was with Sakha 2 (a Sakel type with light creamy-linted colour), and the second cross was with Giza 2 (an Upper strain with creamy-linted colour). Another 19 crosses were made between Egyptian varieties in which the colours of their different parents were not so widely different as between Enan's brown and Sakha 2 or Giza 2. There was a clear evidence that lint colour of the F_1 generation was intermediate between the colours of the two respective parents. Again, Aboul-Ela (1931)[a,b,c], studied the inheritance of lint colour and its correlation with halo length in the previous two crosses between the mutant Enan's brown on one hand, and each of Sakel and Ashmouni on the other hand. He also studied the inheritance of lint colour in F_3 of Sakel x Enan's brown cross. He reached to the conclusion that F_1 was intermediate in colour between the respective parents, and that there was an incomplete dominance for dark colours over light ones. In F_2, the distribution of lint colour was very close to (1:2:1) ratio, but it was somewhat complicated by the intermixing of the different classes, although it was possible by the naked eye to divide the plants into three classes. This gave an evidence that there was one factor difference governing the inheritance of lint colour. In Enan's brown x Ashmouni cross, he found that the lighter coloured classes were somewhat in excess than their expected numbers, while the brown coloured plants were somewhat less. He noticed