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INHERITANCE OF LINT COLOUR IN *DESI* COTTON (*GOSSYPIUM ARBOREUM* L.)

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ABSTRACT

The inheritance of lint colour was studied in five coloured linted genotypes namely Light Brown, SP 3936 (A), *Khaki* Colour 8631, Malvensis and 7869 Brown. The segregation in Bc_1 and F_2 populations developed from coloured × white linted crosses showed fitness of 1:1 and 3:1 ratio, respectively indicating a single gene governing inheritance of lint colour. Though the inheritance appears to be monogenic, test for allelism of the colour linted genotypes indicates presence of three independent loci responsible for lint colour. Expression of lint colour gene in *Khaki* Colour 8631 is similar to Lc_2^B, whereas in Malvensis and 7869 Brown genotype, it resembles to the expression of Lc_3^B. Lc_2^B and Lc_3^B are cumulative in action, when occur together, producing darker lint colour, i.e. brown lint, whereas single dominant allele (Lc_2^B or Lc_3^B) produce light brown lint. Genes carried by Light Brown and SP 3936 (A) are different from Lc_2^B and Lc_3^B. A new independent locus Lc_5 with a gene symbol Lc_5^B responsible for light brown lint is proposed.

Key Words : Coloured cotton, inheritance, lint colour, *G. arboreum* L.

The majority of cottons under cultivation possess white lint, coloured types, on the whole, are relatively uncommon. The wild species including putative donors of present day tetraploid cotton and many wild representatives also have coloured lint. In the Asiatic diploid species *G. arboreum*, brown coloured lint is most common. The lint colour ranges from deep brown, *khaki* to light brown. Inspite of availability of range of expression of colour in the lint very few studies are available on the inheritance of this character.

Hutchinson[1] postulated three factors governing lint colour. Working with the same material, Silow[2] showed involvement of genes at three loci, namely Lc_1, Lc_2 and Lc_3. At Lc_1, a gene for *khaki* Lc_1^K was identified. Lc_2 was identified as multiple allelomorphic locus with its members as *khaki* Lc_2^K, medium brown Lc_2^M, light brown

Lc_2^B and white Lc_2, whereas at Lc_3 only a light brown Lc_3^B gene was identified. Information on lint colours, genetic resources, inheritance, breeding strategies and issues concerning colour cotton cultivation in India has extensively been reviewed[3]. Coloured cotton genotypes available in the germplasm collection at Central Institute for Cotton Research, Nagpur have not yet been characterised for inheritance of lint colour and associated characters. The present investigation was, therefore, undertaken to determine inheritance and number of genes governing lint colour in Asiatic cotton, *G. arboreum* L.

MATERIALS AND METHODS

Five colour linted strains of *G. arboreum*, viz., Light Brown, SP 3936 (A), *Khaki* colour 8631, Malvensis and 7869 Brown and five white linted elite cultivars namely, Y1, K 10, AKH 4, AKA 8401 and Lohit were selected and used as parents in hybridization. Fibre characteristics including 'Rd' and Hunter's '+b' value which are indicators of colour intensity along with fibre characteristics of parents are presented in Table 1. Of the nine crosses made between colour and white linted

Table 1. Lint colour parameters and technological properties of parents

S. No.	Genotypes	Fibre characteristics						
		Lint colour	Colour Parameters		2.5% Span length (mm)	U.R (%)	MIC	Tenacity 3.2 mm (g/tex)
			Rd	+b				
1.	Y1	White	67.6	9.7	26.3	51	5.4	20.1
2.	K 10	White	68.2	9.8	24.4	52	5.3	19.8
3.	AKA 8401	White	67.5	9.9	24.6	51	5.2	20.2
4.	AKH 4	White	68.6	10.0	24.2	53	5.7	18.8
5.	Lohit	White	68.3	9.8	19.3	52	5.8	15.6
6.	Light Brown	Light brown	41.1	18.4	20.6	48	3.2	17.5
7.	SP 3936 (A)	Light brown	40.6	19.8	21.1	50	5.4	18.1
8.	Malvensis	Light brown	41.4	19.8	22.5	47	4.8	16.4
9.	7869 Brown	Light brown	40.8	19.6	24.0	50	4.9	19.0
10.	*Khaki* colour 8631	Light brown/ Khaki	40.1	19.2	20.2	50	5.3	17.1

genotypes, colour linted genotypes were used as female in six, and three were reciprocal. The F_1 generation and parents were raised during *Kharif* 1997 at Central Institute for Cotton Research, Nagpur. Fibre technological characters of all F_1 combinations were compared with respective parents. Few F_1 plants from all the cross combinations were back crossed with respective white linted parents while the rest were rigorously selfed to obtain F_2 generation. Simultaneously, five crosses were made among the selected colour linted lines and the resulting F_1 combinations were crossed with white linted cultivar Y1.

Thus, three types of populations, namely F_2, Bc_1 and Threeway crosses, along with parents were raised in *Kharif* 1998. Plants were grown with a spacing of 60 x 45 cm. and all recommended crop management practices were followed. Segregation for lint colour was recorded on each plant when nearly 70% bolls were open in F_2, Bc_1 and Threeway cross populations. The plants for lint colour were classified into distinct groups by comparing intensity of lint colour with already graded lint samples based on HVI index of Hunter +b value and Rd value. Matching of instrumental grades of lint colour with that of visual, preceded classification of the plants. Fitness of ratios were tested following standard procedures.

RESULTS AND DISCUSSION

The data on lint colour parameters and technological properties (Table 1) indicated that the parents (coloured and white linted lines) used in the present study possesses distinguishing lint colour and technological characteristics. Lint colour intensity was measured using two parameters, i.e. Rd value and Hunter's +b value. Rd value indicates the degree of brightness and the same is expressed in per cent reflectance. Hunter +b value indicates degree of yellowness and the values are in Hinter's +b unit. The intensity of colour measured by these parameters may be approximately same, yet differences for physical appearance of the colour may exist. Thus, visual grading also adds in classification of lint colour.

The F_1's obtained by crossing coloured and white linted lines were tested for colour intensity and technological properties. The observations revealed that the colour intensity and technological properties are intermediate of both the parents involved in each cross (Table 2). The colour intensity of F_1's measured by degree of brightness (Rd values) showed more brightness and less yellowness (+ b values) than the coloured parents. This indicates that the light brown lint colour is incompletely dominant over white. However, physical appearance of the colour of F_1's and the coloured linted parents was not distinct enough to categorize them in different classes. At field level, it becomes next to impossible to distinguish lint colour with

Table 2. Lint colour parameters and technological properties of F_1 crosses in *Desi* cotton

Sr. No.	F1 combinations	Fibre characteristics						
		Lint colour	Colour parameters		2.5% Span length (mm.)	U.R. (%)	MIC	Tenacity 3.2 mm (g/tex)
			Rd	+b				
1.	Light Brown × Y1	Light brown	45.2	18.2	23.3	49	5.5	18.6
2	Y1 × Light Brown	Light brown	44.8	18.2	23.8	49	5.8	15.6
3	SP 3936 (A) × K 10	Light brown	46.4	18.2	26.3	50	5.6	19.8
4.	K 10 × SP 3936 (A)	Light brown	46.2	18.1	22.3	51	5.2	17.4
5.	SP 3936 (A) × AKA 8401	Light brown	46.6	18.3	24.6	49	4.4	16.1
6.	AKA 8401 × SP 3936 (A)	Light brown	44.8	18.2	23.6	48	4.9	17.3
7.	Malvensis × K 10	Light brown	45.8	18.2	23.2	49	5.1	18.2
8.	7869 Brown × Lohit	Light brown	46.2	18.1	22.4	50	5.4	19.0
9.	Khaki Colour 8631 × AKH 4	Light brown	46.6	18.2	22.6	51	5.4	18.2

little differences in colour intensity, as exposure to sunlight (continuously or for longer duration) leads to fading of colour. Therefore, the lint colour of F_1's was categorized as light brown. Such categorization tends to indicate that light brown colour is dominant over white. Reciprocal crosses did not exhibit significant differences with respect to colour intensity and fibre characteristics (Table 2). This indicate that the cytoplasmic differences have little or no bearing on colour intensity, thus provide choice to use either parents (coloured or white linted) as male or female.

The segregants for lint colour in test crossed (with white linted lines) populations (Table 3) had light brown lint of varying colour intensity. Discrete grouping was not possible and hence coloured linted plants were grouped into a single light brown lint class. The segregation into light brown : white linted plants of each populations gave a very good fit to 1:1 ratio, with χ^2 value ranging from 0.00 to 1.285. The pooled segregation also showed fitness of 1:1 ratio (χ^2 = 0.437).

The segregation for lint colour in F_2 (Table 4) also did not deviate significantly from the expected 3:1 ratio which is indicative of presence of a single dominant

Table 3. Segregation for lint colour in backcrosses involving brown coloured and white linted lines of *Desi* cotton

Population	Segregation (No. of plants)			Chi-square (1:1 ratio)
	Light Brown	White	Total	
(Light Brown × Y1) Y1	56	52	108	0.148
(Y1 × Light Brown) Y1	58	62	120	0.133
[SP 3936 (A) × K 10] K 10	44	40	84	0.190
[K 10 × SP 3936 (A)] K 10	62	54	116	0.551
[SP 3936 (A) × AKA 8401] AKA 8401	59	51	110	0.581
[AKA 8401 × SP 3936 (A)] AKA 8401	62	50	112	1.285
(Malvensis × K 10) K 10	13	17	30	0.533
(7869 Brown × Lohit) Lohit	17	17	34	0.000
(Khaki Colour 8631 × AKH 4) AKH 4	51	60	111	0.729
Pooled	422	403	825	0.437
Heterogeneity χ^2				3.713

gene. The F_2 populations and pooled segregation showed fitness of 3:1 ratio. Heterogeneity χ^2 values for both Bc_1 and F_2 populations were non-significant indicating homogeneity among the populations and confirming 1:1 and 3:1 segregation ratios, respectively. The results thus indicate that the inheritance of light brown lint colour is governed by a single dominant gene. However, incomplete resemblance of F_1's between coloured and white linted lines to coloured parents and variation in intensity of colour within coloured linted class in Bc_1 and F_2 populations do support the hypothesis of having more than a single locus or presence of tightly linked two or more than two genes at the same locus imparting light brown colour to the lint. Plants excess in number in coloured linted class of F_2 population of *Khaki* Colour 8631 × AKH 4 may also add to this contention.

Segregation pattern in threeway cross populations (Table 5) appears to be interesting. Two populations namely, [Light Brown × SP 3936 (A)] Y1 and (7869 Brown × Malvensis) Y1 did not show any segregation. All plants were carrying light brown lint. The populations (Light Brown × Malvensis) Y1 and [SP 3936 (A) × Malvensis] Y1 segregated into light brown : white showing fitness of 3:1 ratio. The segregation in the above four population leads to the conclusion that the colour

Table 4. Segregation for lint colour in F_2 population involving brown coloured and white linted lines of *Desi* cotton

Population	Segregation frequency			Chi-square (3:1 ratio)
	Light Brown	White	Total	
(Light Brown × Y1) F_2	341	117	458	0.080
(Y1 × Light brown) F_2	194	72	266	0.606
[SP 3936 (A) × K 10] F_2	214	78	292	0.456
[K 10 × SP 3936 (A)] F_2	174	54	228	0.210
[SP 3936 (A) × AKA 8401] F_2	195	64	259	0.011
[AKA 8401 × SP 3936 (A)] F_2	162	64	226	1.327
(Malvensis × K 10) F_2	174	56	230	0.052
(7869 Brown × Lohit) F_2	160	49	209	0.269
(Khaki Colour 8631 × AKH 4) F_2	278	69	347	4.842
Pooled	1892	623	2515	0.070
Heterogeneity χ^2				7.783

strains Light Brown and SP 3936 (A) carry the same gene for light brown lint colour. Similarly, the colour strains 7869 Brown and Malvensis carry one and same gene for light brown lint colour. However, a gene for lint colour carried by Light Brown and SP 3936 (A) strains in all probabilities differs in location from that of a gene carried by Malvensis strain. The hypothesis would also be true for the gene carried by 7869 Brown strain. Colour expression of both the genes was very much similar which leads to the assumption that the genes may be duplicate placed at different loci.

The segregation for lint colour in (*Khaki* colour 8631 × Malvensis) Y1 population (Table 5) was in three distinct classes, i.e. brown, light brown and white; and the χ^2 value is showing fitness to 1:2:1 ratio. In this case, brown colour was clearly distinguishable from light brown lint colour and hence grouped separately. The nature of segregation indicates involvement of two distinct genes. The segregation was as that of digenic test cross where the genotypes possessing only one dominant allele gave rise to light brown expression while the genotypes possessing two distinct dominant alleles gave rise to brown lint colour. The genotypes possessing both homozygous recessive alleles produced white lint.

The segregation and expression pattern of lint colour in the tested lines corroborate the genetic analysis of the three lint colour loci[2]. Expression of lint colour, degree of dominance and segregation of lint colour gene in *Khaki* Colour 8631 line is similar to Lc_2^B allele while expression in Malvensis and 7869 Brown strains resembles to Lc_3^B allele. The genes carried by Light Brown and SP 3936 (A) lines are essentially similar in expression to that of gene carried by Malvensis. Therefore, it would be regarded as duplicate genes differing in location. Genes carried by *Khaki* colour 8631 and Light Brown and or SP 3936 (A) may not be same considering the differences shown in expression and also segregation for lint colour with Malvensis strain (Table 5).

Table 5. Segregation for lint colour in threeway cross populations of *Desi* cotton

Population	Segregation (No. of plants)				Expected ratio	Chi-square
	Brown	Light Brown	White	Total		
[Light Brown × SP 3936 (A0] Y1	-	130	-	130	-	-
(Light Brown × Malvensis) Y1	-	80	30	110	3:1	0.303
[SP 3936 (A) × Malvensis] Y1	-	139	44	183	3:1	0.067
(7869 Brown × Malvensis) Y1	-	110	-	110	-	-
(Khaki Colour 8631 × Malvensis) Y1	59	122	47	228	1:2:1	2.385

Segregation for lint colour in (*Khaki* Colour 8631 × Malvensis) Y1 population shows lint class of brown colour. Probably, Lc_2^B and Lc_3^B are cumulative in effect and if both occurs together in dominant form produce darker lint colour whereas a single dominant allele (Lc_2^B or Lc_3^B) produces light brown lint. Silow [2] also indicated that Lc_2^B and Lc_3^B are cumulative in effect and their expression is more darker than Lc_2^K allele, if they occur together in homozygous state. An assumption of presence of Lc_2^B or Lc_3^B genes in the tested strains in the present study is supported by the findings that different strains of Cocanadas carry Lc_2^B and Lc_2^v genes[4],. The fact is *desi* colour cotton varieties Cocanadas and Red Northerns were under commercial cultivation in India and most of the coloured cotton germplasm lines collected in explorations carried genes from these primitive varieties. It has already been indicated that the gene for coloured lint carried by Light Brown and or SP 3936 (A) is different from the above mentioned one. Hence, a new independent locus Lc_5 with a gene symbol Lc_5^B determining light brown lint colour in the above strains is proposed.

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