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GENETICAL STUDIES ON OFFTYPES OF SOME EGYPTIAN COTTONS
2- GENETICAL CHANGES IN THE ORIGINAL COTTON GENOTYPES AND GENETIC CONSEQUENCES OF THE HAPHAZARD TRANSFER OF N-C GENES ON LINT QUALITY

Abo-Arab, A.R.*, S.M. Abd El-Sayyed ** and Y.M. El-Mansy *
*** Cotton Research Institute** **** Fac. Agric. Zagazig University**

ABSTRACT

The present investigation was carried out at Sakha Agricultural Research Station over three cotton growing seasons 1997, 1998 and 1999. The two Egyptian cotton varieties, "Giza 45" and "Giza 76" belonging to *Gossypium barbadense* L. as well as their spontaneous induced offtypes, were used in this investigation. The results showed significant differences between the original parents and their derived offtypes for fibre characters in both varieties indicated that these changes appeared to be genetic alterations, one or more, mutant locus. Both naked-creamy parental offtypes showed higher values of fibre fineness and degree of yellowness, but lower lint reflectance value than the original varieties. The F_2 frequency distribution curves of the two crosses were characterized by a kind of unimodality confirmed the polygenic nature of genes controlling such changes in lint quality. The additive gene effects were the prevailing in governing the lint quality changes in both crosses besides, some various types of non allelic interaction only in the cross, Giza 45 x naked-creamy offtypes, reflecting that the induced naked-creamy offtypes possessed different genetic system varied in their action. The detected high heritability values in both crosses for the studied fibre quality characters indicated the possibility of selection for better lint quality values and eliminate such offtypes in early segregation generations.

INTRODUCTION

Homogeneity and uniformity of lint quality characters represent the practical criteria for identification and judging the purity of the cotton cultivars, maintaining genetic purity among cotton genotypes offers a measure of protection against degeneration of yield potentials.

These changes could lead to degenerate of the Egyptian cotton and to the market rejection of these varieties, if they haphazardly multiplicate. Many investigators studied these changes, Abo-Arab (1990), Fayed *et al*. (1990) and Abo-Arab *et al*. (1992) studied the lint colour offtypes isolated from Egyptian cotton varieties Giza 70, Giza 76 and Giza 77 as well as their F_1 and F_2 progenies derived from crossing these offtypes with their original varieties. They found that these changes in lint colour appeared to be under polygenic nature and the additive genetic effects. Geng *et al*. (1998) studied the effect of coloured fiber genes on the properties of Upland cotton. They found that the coloured fiber genes had negative effects on lint yield and fiber quality characters.

This work was aimed to study the genetic consequences of the haphazard transfer of the naked seed-creamy lint offtypes on lint characters in the successive generations, as crossed with their original parents.

MATERIALS AND METHODS

A. Materials:

The two Egyptian cotton varieties, "Giza 45" and "Giza 76", belonging to *Gossypium barbadense* L. as well as their offtypes, (three offtypes for each) were used in this investigation.

Selfed seeds of both the original varieties and their offtypes were sown and crossed in the growing season of 1997. Each original variety was crossed with its three offtypes in the two directions (straight and reciprocal) to obtain the seeds of six F_1 hybrids.

In the growing season of 1998, F_1 seeds, obtained from crossing each original variety with its naked seed-creamy lint offtypes, were sown and selfed or back crossed to obtain their F_2, BC_1 and BC_2 and seeds.

The present investigation was carried out at Sakha Agricultural Research Station, Kafr El-Sheikh Governorate, Egypt, during the growing seasons of 1997, 1998 and 1999.

B. Methods:

1. Field procedures:

To study the genetical changes in each original variety, a randomized complete blocks design experiment was conducted with three replicates in the growing season of 1998. Each replicate consisted of 10 rows, one row for each genotype, parent or F_1 hybrid. Each row comprized fifteen plants. Normal cultural practices were applied as recommended for ordinary cotton growing. At the end of the growing season, plants were separately harvested and ginned.

For studying the genetic consequences of the haphazard transfer of the naked-creamy offtype genes on lint quality, seeds of parents, F_1, F_2 generations and back crosses of each cross were sown in the growing season of 1999. A randomized complete blocks design experiment was conducted with three replicates. Each replicate comprized three rows for each parent or F_1 hybrids. Eight rows for each back cross and 20 rows for F_2 population. Each row comprized 10 plants. All the ordinary practices of cotton cultivation were applied.

At the end of season, plants of each entry were separately harvested and ginned in order to examine the effect of naked-creamy offtype on lint properties.

2. Laboratory procedures:

Fibre fineness and lint colour characters were studied in the growing season of 1999 on plants of the six populations; P_1, P_2, F_1, BC_1, BC_2 and F_2; derived from crossing each original variety with its naked-creamy offtype.

All the fibre tests were carried out at the Technology Section, Cotton Research Institute, Agric. Res. Center, Giza.

3. Statistical procedures:

All the studied characters in the first season 1998, were statistically analyzed on plot mean basis. The original data of fibre fineness and lint colour characters were transformed into arc sin.

A separate analysis of variance for each cross was done to detect the significant of the observed differences as described by Sokal and Rohlf (1995).

The frequency distributions, ranges, means and variances of P_1, P_2, F_1, BC_1, BC_2 and F_2 populations were calculated for lint quality characters. The obtained generations means and variances were used to compute the scaling tests; A, B and C; and to estimate the type of gene effects and their significances using student's t-test as described by Kearsy and Pooni (1996).

Heterosis was determined as the deviation from the mid-parents ($\overline{MP}$) and over better parent value ($\overline{BP}$), and total heterosis values were also estimated according to Abo-Arab (1990).

The genotypic and environmental components of variation were computed from the data of the segregating and non-segregating generations variances.

Heritability values in broad ($h^2{}_b$) and narrow ($h^2{}_n$) senses were also estimated (Kearsy and Pooni 1996).

RESULTS AND DISCUSSION

A. Genetical changes in the original cotton genotypes:

The analyse of variance for all studied fibre traits are shown in Table 1. The results showed significant mean squares of genotypes, parents or crosses for all studied traits indicating the presence of genetic variability. In addition significant differences were observed between the original parents and their derived offtypes for all studied traits in both “Giza 45” and “Giza 76”. Moreover, the offtypes showed significant differences among each other. This finding indicated that such changes appeared to be genetical alterations, i.e. one or more mutant locus.

Table 1: Analysis of variance for lint characters studied among the original variety Giza 45, Giza 76 and their offtypes as well as their F_1's hybrids.

Source of variation	d.F	Mean square of the studied characters					
		Giza 54 genotypes			Giza 76 genotypes		
		FF	Rd	+ b	FF	Rd	+ b
Replicates	2	0.0022	0.4990	0.1060	0.3306*	0.1545	0.1461
Genotypes	9	2.5680*	11.0453*	3.8867*	1.1570*	22.7282*	4.7253*
Parents	3	4.0114*	22.9629*	8.0631*	3.0781*	41.9356*	9.6467*
Offtypes	2	3.6699*	26.2434*	11.5693*	3.6183*	24.7677*	11.1289*
@ O. V. vs offtypes	1	4.6944	16.4020*	1.0506*	1.9976*	76.2714*	6.6822*
Crosses	5	2.2147*	6.0197*	2.1250*	0.2310*	6.2219*	1.8655*
Straight F_1	2	1.6534*	10.4934*	2.5853*	0.2294	10.7377*	2.9742*
Reciprocal F_1	2	3.8830*	4.4934*	2.5452*	0.3331*	4.8100*	1.5244*
Str. vs. recip.	1	0.0010	0.1249	0.3641	0.0304	0.0140	0.3307
Parents vs. crosses	1	0.0045	0.4210	0.1658	0.0240	47.6380*	4.2601*
Rep. x genotypes	18	0.0628	0.4290	0.1149	0.0703	0.1873	0.0779
Rep. x parents	6	0.0911	0.4501	0.1550	0.0748	0.1931	0.0096
Rep. x crosses	10	0.0409	0.3663	0.0988	0.0661	0.2209	0.1311
Rep. x P. vs. C.	2	0.0873	0.6789	0.0752	0.0782	0.0019	0.0169

@ O.V. : Original variety *** Significant at 5% level** **"Giza 54" and "Giza 76"**

Mean squares of F_1 crosses, either straight or reciprocal cross, were also significant for all studied traits in both "Giza 45" and "Giza 76" except straight cross for fibre fineness in Giza 76 revealing that such changes could be transmitted across generations. Meanwhile, mean squares of straight versus reciprocal were insignificant in these traits, reflecting the absence of maternal, cytoplasmic, effects. Furthermore, parents versus crosses mean squares were significant for lint colour traits in "Giza 76" genotypes showing some sort of heterotic effects. In this respect, Abo-Arab (1990) and Abo-Arab *et al*. (1992) found distinctive differences between the original cotton genotypes "Giza 70", "Giza 76" and "Giza 77" and their lint colour offtypes as well as their F_1 progenies.

B. Genetic consequences of the haphazard transfer of the N-C genes on lint quality:

The nature of the genetic components and gene actions involved in the characterization of the haphazard transfer of such N-C genes to their original varieties were studied on lint traits. The genetic consequences of such a transfer were investigated in F_1, F_2, BC_1 and BC_2 generations derived from crossing N-C offtypes to their original parental genotypes, "Giza 45" and "Giza 76".

Table 2: Generations means and their standard errors for fibre quality characters of the studied populations in cotton crosses.

Populations	N	Fibre fineness (micronaire)		Lint reflectance %		Degree of yellowness (Hunter units)	
		1st cross +	2nd cross ++	1st cross +	2nd cross ++	1st cross +	2nd cross ++
P_1	25	9.63 ± 0.075	9.83 ± 0.077	57.28 ± 0.160	58.21 ± 0.136	18.40 ± 0.093	17.58 ± 0.084
P_2	25	12.18 ± 0.092	12.15 ± 0.082	51.12 ± 0.175	50.54 ± 0.171	21.44 ± 0.099	22.10 ± 0.087
F_1	25	11.37 ± 0.078	10.80 ± 0.082	54.82 ± 0.194	55.68 ± 0.163	19.76 ± 0.084	19.28 ± 0.100
BC_1	*	10.50 ± 0.085	10.27 ± 0.078	55.83 ± 0.154	56.81 ± 0.193	19.42 ± 0.087	18.51 ± 0.113
BC_2	*	11.34 ± 0.087	11.30 ± 0.082	53.52 ± 0.174	53.20 ± 0.252	20.42 ± 0.089	20.58 ± 0.133
F_2	172	11.32 ± 0.066	10.76 ± 0.053	54.56 ± 0.123	55.09 ± 0.171	20.06 ± 0.067	19.63 ± 0.095

*** Number of plants was 70 and 55 plants in the first and second crosses, respectively.**
+ Giza 45 x naked seed with creamy lint ++ Giza 76 x naked seed with creamy lint

Frequency distribution curves, ranges and means, for fibre fineness, lint reflectance and degree of yellowness, of the parents and their derived successive generations are presented in Figures 1-3 and Table 2. The results revealed that the differences between the original parents and their offtypes were clearly distinctive and not overlapped. Both naked-creamy parental offtypes showed higher values of fibre fineness and degree of yellowness, but lower lint reflectance value than the original varieties. These results were similar to the findings of Abo-Arab (1990). He found significant differences in lint colour among three Egyptian cotton varieties and their offtypes.

The behaviour of F_1 hybrid "Giza 45 x naked-creamy" showed a slight tendency, in fibre fineness and degree of yellowness, towards its P_2 (the offtypes) and, in lint reflectance, towards its P_1, (Giza 45). Meanwhile, F_1 hybrid "Giza 76 x naked-creamy" appeared to tend towards its P_1 (Giza 76) for all studied fibre traits. These observations suggested that the altered genes in both offtypes seemed to be different and varied in their action according to the induced change on the studied lint traits. Similar results were observed by Abo-Arab (1990) and Fayed *et al*. (1990). They found partial dominance controlling lint colour in F_1 hybrids between some cotton varieties and their lint colour offtypes. Similarly, Hassoub (1991) and El-Lawendey (1999) found partial dominance governing fibre fineness.

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The F_2 frequency distribution curves of the two crosses were characterized by a kind of unimodality indicating the continuous type of variation for these fibre traits which due to the joint action of polygenes, i.e. polygenic additive system controlling such variations in F_2 (Figures 1-3). This polygenic nature was also confirmed by the distribution curves of BC_1 and BC_2. Many investigators reported that polygenic additive system was predominant in the expression of fibre traits which were in accordance with the results among them (Abo-Arab, 1990 and Abo-Arab *et al*., 1992).

Table 3: Scaling tests values (A, B and C) and type of gene effects for the studied fibre quality characters in cotton crosses.

Populations	Fibre fineness (micronaire)		Lint reflectance %		Degree of yellowness (Hunter units)	
	1st cross +	2nd cross ++	1st cross +	2nd cross ++	1st cross +	2nd cross ++
Scaling tests						
A	0.00 ± 0.20	-0.09 ± 0.19	-0.44 ± 0.40	-0.27 ± 0.44	0.68* ± 0.21	0.16 ± 0.26
B	-0.87* ± 0.21	0.35 ± 0.20	1.10* ± 0.43	0.18 ± 0.56	-0.36 ± 0.22	-0.22 ± 0.30
C	0.73* ± 0.33	-0.54 ± 0.29	0.20 ± 0.67	0.25 ± 0.79	0.88* ± 0.34	0.28 ± 0.45
Gene effects						
a	-0.84* ± 0.12	-1.03* ± 0.11	2.31* ± 0.23	3.61* ± 0.32	-1.00* ± 0.12	-2.07* ± 0.17
d	-1.14* ± 0.37	-0.09 ± 0.33	1.08 ± 0.71	0.97 ± 0.95	-0.72 ± 0.38	-0.90 ± 0.53
aa	-1.60* ± 0.36	0.10 ± 0.31	0.46 ± 0.67	-0.34 ± 0.93	-0.56 ± 0.37	-0.34 ± 0.52
ad	0.44* ± 0.13	0.13 ± 0.27	-0.77* ± 0.26	-0.23 ± 0.34	0.52* ± 0.14	0.19 ± 0.21
dd	2.34* ± 0.58	0.34 ± 0.54	-1.12 ± 1.15	0.43 ± 1.44	0.24 ± 0.61	0.40 ± 0.83

*** Significant at 5%　　+ "Giza 45 x naked creamy"　　++ "Giza 76 x naked creamy"**

The results of scaling tests A, B and C are given in Table 3. It was worthy to mention that at least one of the A, B and C tests was significant in the first cross (Giza 45 x naked-creamy) but these tests were insignificant in the second cross (Giza 76 x naked-creamy). These results indicated the role of non-allelic interaction governing the studied traits in the first cross and the absence of these genetic effects in the second cross.

The gene effects calculated as an average of genes governing some lint quality traits (Table 3) showed that the additive gene effects were the prevailing in both crosses. Besides, various types of non-allelic interactions controlling these traits in the cross (Giza 45 x naked-creamy) only. The different sings observed in the additive gene effects among the two crosses might reflect that the induced naked-creamy offtypes possessed different additive genes varied in their action. These conclusions assured the different nature of the induced N-C offtypes in their action and interaction in both cotton varieties. These results were in harmony with those reported by Rahouma *et al*. (1989), Abo-Arab (1990) and Gomaa (1997).

Comparing F_1 means with their mid-parent values ($\overline{MP}$), the results showed significant positive heterotic effects for fibre fineness in the first cross and lint reflectance in both crosses, as well as significant negative heterosis for degree of yellowness in the second cross (Table 4).

Both of F_1 crosses manifested significant positive heterosis for fibre fineness and degree of yellowness over their better parents (BP). This finding indicated that F_1 crosses were more coarser and yellowness than the original varieties. However, the significant negative heterotic effects detected for lint reflectance in both of F_1 crosses indicated the lower lint colour reflectance of F_1 crosses than their better parents, original varieties.

Table 4: Estimation of heterosis and total heterosis for the studied fibre quality characters in two cotton crosses.

Parameters	Fibre fineness (micronaire)		Lint reflectance %		Degree of yellowness (Hunter units)	
	1st cross +	2nd cross ++	1st cross +	2nd cross ++	1st cross +	2nd cross ++
Heterosis MP	4.22*	-1.73	1.14*	2.39*	-0.80	-2.82*
Heterosis B.P	18.07*	9.87*	-4.29*	-4.35*	7.39*	9.67*
Component of heterosis						
-a	0.84	1.03	-2.31	-3.61	1.00	2.07
d	-1.14	-0.09	1.08	0.97	-0.72	-0.90
-aa	1.60	-0.1	-0.46	0.34	0.56	0.34
1/2 ad	0.22	0.07	-0.39	-0.12	0.26	0.10
Total heterosis	1.52*	0.91	-2.08*	-2.42	1.10*	1.61*

*** Significant at 5%** **+ "Giza 45 x naked creamy"** **++ "Giza 76 x naked creamy"**

Moreover, total heterosis, expressed in terms of four components of the generations means, were significant in the first cross for all studied traits and completely confirmed the previous results (Table 4). But, significant total heterosis was detected in the second cross only for degree of yellowness. These results were in harmony with the findings of Ano *et al*. (1983). El-Okkia *et al*. (1989), Abo-Arab (1990) and Abo-Arab *et al*. (1992) who fond significant total heterosis for lint colour.

The data in Table 5 revealed that the additive component of genetic variance played a considerable role in controlling lint colour traits in the second cross which were confirmed by high narrow sense heritability estimates. However, these fibre traits appeared to be controlled by additive and non-additive gene effects in the first cross as expressed by high genotypic variances which were reflected in high broad sense heritability estimates.

Table 5: Component of the total variance and heritability estimates for the studied lint characters in cotton crosses.

Parameters	Fibre fineness (micronaire)		Lint reflectance %		Degree of yellowness (Hunter units)	
	1st cross +	2nd cross ++	1st cross +	2nd cross ++	1st cross +	2nd cross ++
Add. var.	-	0.257	-	4.497	-	1.442
Dom. var.	-	0.065	-	-0.098	-	-0.093
Genoty. var.	0.562	0.322	1.821	4.399	0.555	1.349
Enviro. var.	0.166	0.161	0.781	0.618	0.213	0.206
Phenoty. var.	0.728	0.483	2.602	5.017	0.768	1.555
h^2 broad/s	77.19	66.67	69.98	87.68	72.27	86.75
h^2 narrow/s	-	53.28	-	89.64	-	92.73

+ "Giza 45 x naked-creamy" **++ "Giza 76 x naked-creamy"**

It was clear that fibre fineness and lint colour were less affected by environmental factors, since differences between phenotypic and genotypic variance appeared to be relatively low. Abo-Arab (1990); Abo-Arab *et al*. (1992); Gomaa (1997); Kosba *et al*. (1999) and Hamoud (2000) reported the importance of additive genetic variance for fibre properties. While, El-Okkia *et al*. (1989) and Soliman (1999) stated the importance of non-additive gene effects for the fibre properties.

It could be noticed that the similar behaviour of naked-creamy offtypes in both "Giza 45" and "Giza 76" might suggest that these offtypes possessed coarseness and darkness genes, not necessarily the same genes but others with the same action.

Finally, the highly estimates of heritability values in both crosses for the studied fibre quality traits gave the possibility to condense selection for better lint quality values and to eliminate such offtypes from the original cotton varieties for preventing their degenerations.

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دراسات وراثية على الطرز المغايرة لبعض الاقطان المصرية
2- التغيرات الوراثية فى القطن والاثار الوراثية الناتجة عن النقل العشوائى لجينات الطراز المغاير "بذرة عارية شعر كريمى" على صفات جودة التيلة

احمد راضى ابو عرب * ، سلامة ميخائيل عبد السيد ** و ياسر محمد المنسى*
*** معهد بحوث القطن - ** كلية الزراعة - جامعة الزقازيق**

أجرى هذا البحث بمحطة البحوث الزراعية بسخا خلال ثلاث مواسم زراعية هى 1997 ، 1998 و1999. أستخدم فى هذه الدراسة صنفين من القطن المصرى هما جيزه 45 ، جيزه 76 وهما يتبعان *G. barbadense L.* مع الطرز المغايرة المستحدثة تلقائيا لكل صنف. وكانت من أهم النتائج المتحصل عليها ما يلى:

1- لوحظ وجود إختلافات معنوية بين الآباء الأصلية والطرز المغايرة لها فى صفات التيلة المدروسة فى كلا الصنفين مما يدل على أن هذه التغيرات نتيجة إختلافات وراثية فى موقع أو أكثر.
2- أظهرت كل من الاباء العارية البذرة - كريمى الشعر قيم عالية فى نعومة التيلة ودرجة الاصفرار بينما اظهرت قيم منخفضة لدرجة الانعكاس بالمقارنة بالاصناف الاصلية.
3- تبين من منحنيات التوزيع التكرارى للجيل الثانى فى كلا الهجينين أن التغير فى صفات التيلة كان محكوما بفعل الجينات المتعددة.
4- كانت التأثيرات الجينية المضيفة الأكثر تحكما فى وراثة التغيرات فى صفات التيلة فى كلا الهجينين بجانب بعض التأثيرات غير الأليلية فى الهجين (جيزه 45 × عارية - كريمى) فقط. مما يعكس إختلاف الفعل الجينى لهذا الطراز المغاير.
5- إرتفاع قيم المكافئ الوراثى فى كلا الهجينين لصفات الجودة يمكننا من تحسين هذه الصفات عن طريق الإنتخاب لأحسن الصفات وأيضا لإستبعاد مثل هذه الطرز المغايرة فى الأجيال الإنعزالية المبكرة.