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GENETICAL STUDIES ON OFFTYPES OF SOME EGYPTIAN COTTONS
1. GENETIC DIVERGENCE AMONG COTTON GENOTYPES

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ABSTRACT

The present investigation was carried out at Sakha Agricultural Research Station, Kafr El-Sheikh, Egypt, during the two growing seasons of 1997 and 1998. Two Egyptian cotton varieties, “Giza 45” and “Giza 76”, belonging to *Gossypium barbadense* L. as well as their spontaneous offtypes, three offtypes for each, were used in this investigation. The principal components analysis indicated that the first four components accounted for more than 95% of the total variance over all studied traits, while the first principal component accounted for about 60% and 73% of all multivariate variation among genotypes for "Giza 45" and "Giza 76", respectively. Seed cotton yield/plant followed by lint index were the major contributer to genetic divergence among "Giza 45" genotypes, while lint colour, degree of yellowness and reflectance, contributed mostly to genetic divergence among "Giza 76" genotypes, reflecting the varied genetic architecture of both genotypes. The genetic divergence among the original parents and their offtypes based on Euclidean distances revealed the “naked seed-creamy lint” offtype, in both varieties, was wide divergent from their original parents and the other offtypes which were less divergent, exhibiting the largest dissimilarity coefficients. The dissimilarity coefficients between the reciprocal F_1 hybrids in both varieties, were not significant showing their close relationships and confirming the absence role of any maternal effects on genetic divergence. The naked-creamy offtype either in Giza 45 or in Giza 76 was widely distinct from its straight or reciprocal F_1 hybrids showing significant dissimilarity coefficients, such coefficients were more wide in Giza 76 rather than in Giza 45. The ten genotypes, four parents and six F_1 hybrids, were grouped into four clusters either among "Giza 45" or "Giza 76" genotypes based on the extent of their relative dissimilarities.

INTRODUCTION

Yield and lint characteristics of cotton are considered the main properties in the cotton production and industry. Homogeneity and uniformity of such characteristics 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.

In the last decades, some Egyptian varieties have showed a kind of changes in their homogeneity and uniformity and eventually some offtypes are spontaneously induced, in seed and lint characteristics. These changes could lead to degeneration of the Egyptian cotton and to the market rejection of such varieties. If they haphazardly multiplicated. Some colour offtypes were detected among the Egyptian cotton varieties Giza 70, Giza 76 and Giza 77. These spontaneous offtypes of cotton were studied with respect to attributes to the breeding and agronomic values.

They appeared to be a like in some agronomic characteristics but considerably varied in their lint quality (Abo-Arab, 1990 and Fayed *et al.,* 1990a).

The importance of genetic diversity as a significant factor contributing towards differentiation of cotton has been stressed by several investigators, Kalsy *et al*. (1995) investigated genetic divergence and heterosis in Upland cotton applying D^2 statistic. They found no correspondence between the divergence of the parents and the expression of heterosis in their F_1 hybrids. Amudha *et al*. (1997) found wide divergence among coloured lint cottons, two green and eight brown linted, and white varieties as distributed into separate clusters and Abd El-Sayyed *et al*. (1998) investigated genetic divergence in *G. barbadense* L. genotypes, based on Euclidean distances and showed the Russian genotype "Karshenseki-2" and the Egyptian genotype " Dandra" formed a wide cluster having divergent distance than the other genotypes and, both genotypes appeared to be nearly related.

The present investigation was aimed to study the genetic relationships between some offtypes occurred in the Egyptian cotton varieties, and their original varieties as well as between them and their F_1 progenies on the basis of their degree of total genetic divergence.

MATERIALS AND METHODS

A. Materials:

Two Egyptian cotton varieties, Giza 45 and Giza 76, belonging to *Gosypium barbadense* L. as well as their offtypes, three offtypes for each, were used in this study.

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 six F_1's seeds.

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

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 season of 1998. Each replicate consisted of 10 rows, one row for each genotypes, parent or F_1 hybrids. Each row comprized 15 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.

2.Laboratory procedures:

The following characters were studied on 10 randomly chosen plants of each parent or F_1 hybrid per replicate in the season of 1998, seed cotton yield/plant (SCY) in gm, lint index, (LI), lint percent (LP), number of seeds/boll

(S/b), fiber fineness (FF), fiber length as span length at 2.5%, colour reflectance (Rd) and degree of yellowness (+b).

3.Statistical procedures:

The original data of seed cotton yield/plant and lint index traits were transformed before the statistical analysis into $\sqrt{X+15}$ and $\sqrt{X+10}$, respectively. However, values of lint percent, fiber fineness and lint colour characters were transformed intro arc-sin.

Multivariate technique were used to assess the similarities among varied genotypes and to evaluate morphological parameters contributing to the variation for this purpose, principal components analysis was calculated. The principal components of the contributed characters associated with both “Giza 45” and “Giza 76” genotypes were expressed as eigen values, latent roots and manifested in eigen vector for all the studied characters in each principal component axis. Since, each component score was a linear combination of the traits. The maximal amounts of variations could be shown of the first principal component axis (Hair *et al.,* 1987).

Hierarchical clustering procedure using ward's minimum variance method, which minimize within group sum of squares across all partitions, was applied to determine the genetic diversity and distances. The procedure used a method performing a disjoint cluster analysis on the basis of Euclidean distances as outlined by Anderberg (1973) and Nei (1973) and developed by Johnson and Wichern (1988).

RESULTS AND DISCUSSION

Genetic divergence studies in cotton have been revealed some interesting features of differentiation and adaptability importance. Such an analysis could provide useful additional information, studying interrelationships of genotypes and giving graphical assessment of genetic variability.

1.Multivariate analysis:

In an analysis with eight variables, eight axes were existed, however, only those which exhibited high multivariate variation were considered. The first four principal components, PC, axes accounted for more than 95% of the total variation associated with the first four principal components axes as well as their eight vectors of each character for each of Giza 45 and Giza 76 are shown in Table 1.

Principal components analysis showed that the first PC axes accounted for about 60% and 73% of the multivariate variation among genotypes, showing the highest joint eigen values, for Giza 45 and Giza 76 genotypes, respectively. While, the fourth PC axis contributed with about 4%. In this regard, Cai *et al*. (1996) stated that the first two PCs controlled earliness in cotton contributed with about 91% of the accumulative variance. While, You *et al*. (1998) selected three PCs and found that their accumulative contribution percentage of variance reached to 85% which agreed with our findings.

Table 1: Principal components analysis of characters associated with "Giza 45" and "Giza 76" genotypes * showing eigen values+ and eigen vectors of characters in the first four PC axes.

Parameters	PC axes 1	2	3	4
Giza 45 genotypes				
Eigen values	4.439	2.353	0.397	0.310
PC % of variation	59.231	29.413	4.958	3.871
Cumulative proportion of variation	59.231	88.645	93.602	97.473
Characters	**Eigen vectors**			
Seed cotton yield/plant	-0.963	-0.147	0.152	-0.079
Lint percent	-0.906	-0.300	0.151	0.213
Lint index	-0.941	-0.240	0.035	0.025
Seeds/boll	-0.846	-0.191	-0.279	0.038
Fibre fineness	-0.939	-0.178	-0.207	-0.174
Lint reflectance	0.480	-0.843	-0.161	0.126
Degree of yellowness	-0.488	0.807	0.231	0.063
Span length at 2.5%	0.195	-0869	0.387	-0.105
Giza 76 genotypes				
Eigen values	5.856	0.928	0.600	0.339
PC % of variation	73.198	11.599	7.503	4.199
Cumulative proportion of variation	73.198	84.797	92.300	96.499
Characters	**Eigen vectors**			
Seed cotton yield/plant	-0.857	-0353	-0.104	-0.351
Lint percent	0.812	-0.463	-0.078	0.246
Lint index	0.773	0.339	-0.515	-0.128
Seeds/boll	-0.782	-0.559	-0.160	0.111
Fibre fineness	-0.862	0.075	-0.387	0.019
Lint reflectance	0.898	-0.339	-0.216	-0.111
Degree of yellowness	-0.966	0.105	0.140	-0.109
Span length at 2.5%	0.879	-0.171	0.276	-0.288

+ Latent roots

The principal components analyse showed that seed cotton yield was a primary source of variation with the largest coefficient in the first PC axis among Giza 45 genotypes. Lint index appeared to have the second largest coefficient, followed by fiber fineness. However, span length 2.5% had the smallest coefficient in the first PC axis but, it exhibited the largest coefficient in the second PC axis (Table 1). This trend was changed among Giza 76 genotypes. Since, principal components analyse showed that lint yellowness was a primary source of variation having the largest coefficient in the first PC axis followed by lint reflectance %. However, lint index and number of seeds/boll exhibited the smallest coefficients followed by lint percent in the first PC axis (Table 1). These findings indicated that yield characters were more important in principal components analysis among Giza 45 genotypes but, lint quality characters were important in these analyse among Giza 76 genotypes. Gutierrez *et al*. (1988) found that plant height and fiber length were the most important characters for PC_1, fiber yield for PC_2 and fiber strength and fineness for PC_3.

Therefore, the first two PC axes were used for representation the ten genotypes of each Giza 45 and Giza 76 as shown in Figure 1. It could be noticed that the second principal component axis, PC_2, separated the offtype naked seed with creamy lint and its F_1 progenies from the other genotypes, either original genotypes or other offtypes as well as their F_1 progenies. This finding was true in both cultivars Giza 45 and Giza 76. The arrangement of the other genotypes was corresponded to their common parent, original genotypes, rather than to the offtypes as clearly observed among Giza 76. However, this was not detected among genotypes involved Giza 45. Since, the original parent Giza 45 manifested as case of wide separation from the other genotypes which included it. These results evident that the reciprocal F_1's were not separated from each other.

By viewing these results, one could obtain a visual non numeric grasp of the amount of genetic variability existing among the Egyptian cotton. Since, such an analysis over time would be useful in describing any movement in the genetic bases of our cotton.

2.Hierarchical clustering analysis:

This procedure, using disjoint cluster analysis on the basis of Euclidean distance, was applied to illustrate relative genetic distances and genetic diversity within a given germplasm base.

a.Among original genotypes and their offtypes:

The squared Euclidean dissimilarity coefficients between the original cotton parents, "Giza 45" and "Giza 76", and their offtypes corresponding to the six possible comparisons taking two genotypes at a time for each parent are given in Table 2. These estimates that treated as Chi-square values showed that all the dissimilarity coefficients were significant in both parents, except between the two offtypes of "Giza 76", full fuzz and white flower (X^2 at 0.05 for 8 degree of freedom = 15.51). These coefficients were ranged among "Giza 45" genotypes from 24.46, between the original parent and full fuzz offtype, to 101.70, between the original parent and naked-creamy offtype. However, among "Giza 76" genotypes, these coefficients ranged from 10.21, between the full fuzz offtype and white flower offtype, to 180.30, between "Giza 76" and the naked-creamy offtype.

Figure 2 showed that the naked seed with creamy lint offtype in both parents, "Giza 45" and "Giza 76" appeared to be widely divergent from their original parents rather than other offtypes which were less divergent. The same offtype, naked seed and creamy lint, was also divergent from the other two offtypes. This was true in both genotypes, "Giza 45" and "Giza 76". Moreover, the other two offtypes of Giza 45 were also tightly divergent, but those of Giza 76 were closely related. These results agree with the findings of Abo-Arab (1990) and Fayed *et al*. (1990a) they found distinctive variations between some cotton cultivars and their offtypes.

Table 2: Squared Euclidean dissimilarity coefficients among the original genotypes and their offtypes in matrix form.

Genotypes	1-Giza 45 and its offtypes.			
	G.45	**N**	**N.C**	**F.F**
G.45	0.00			
N	26.7496*	0.00		
N.C	101.7023*	67.1203*	0.00	
F.F	24.4588*	52.4490*	70.2417*	0.00
	2. Giza 76 and its offtypes			
	G.76	**N.C**	**F.F**	**W.F**
G.76	0.00			
N.C	180.2957*	0.00		
F.F	50.7812*	96.8651*	0.00	
W.F	29.1186*	93.9599*	10.2094	0.00

* **Significant at 0.05 (X^2 at 0.05 for 8 degree of freedom = 15.51).**

The wide divergence of the naked seed with creamy lint offtypes than the other genotypes might assure the occurrence of double spontaneous alterations. Such alterations might be induced simultaneously in the seed and lint characters in both "Giza 45" and "Giza 76" varieties. While the other offtypes seemed to be a single alteration only in seed characters or flower colour.

b. Among original genotypes and their F_1 progenies:

Table 3 showed significant values in most F_1 crosses as exceeded Chi-square value at 0.05 for 8 degree of freedom. The dissimilarity coefficients between the F_1 crosses involved the naked-creamy offtype and their original genotypes exhibited significant higher scores compared with the other F_1 crosses involved the other offtypes. These dissimilarity coefficients were clearly pronounced in "Giza 76" F_1 crosses rather than in "Giza 45" F_1. These findings cleared the widest divergence distances as illustrated in Figure 3. However, the dissimilarity coefficients between the F_1 crosses involving the other offtypes and their original parents showed significant moderate scores. Such significances were clearly manifested in either straight or reciprocal crosses of " Giza 45" but not pronounced in the reciprocal crosses of "Giza 76".

It is interest to note that the dissimilarity coefficients between the reciprocals, between straight cross and its reciprocal in both "Giza 45" and "Giza 76", were not significant showing that these reciprocals were approximately close to each other in their genetic relationships. Such a result might indicate the absence of cytplasmic, maternal, effects on genetic divergence. These conclusions agreed with those reported by Abd El-Sayyed and El-Bana (1986) who stated that cytoplasmic effects did not play a considerable role in causing divergence among some F_1 interspecific hybrids of cotton.

Table 3: Squared Euclidean dissimilarity coefficients between the original parents and their derived F_1's as well as between reciprocals F_1's.

Crosses	Dissimilarity coefficients between parents and their		Dissimilarity coefficients between reciprocal F_1's
	Straight F_1	Reciprocal F_1	
G.45 x N.	17.5679*	23.5899*	1.7770
G.45 x N.C	40.0746*	37.0430*	2.2962
G.45 x F.F	29.7068*	12.5595	6.2307
G.76 x W.F	10.1649	9.7690	1.4699
G.76 x N.C	72.2902*	66.8035*	6.2282
G.76 x F.F	22.3076*	9.2658	2.6909

*** Significant at 0.05 (x^2 at 0.05 for 8 degree of freedom = 15.51)**

c. Among offtypes and their F_1 progenies:

The data from Table 4 showed that the naked-creamy offtype either in "Giza 45" or in "Giza 76" was widely distinct from its F_1 crosses straight or reciprocal F_1 crosses showing significant dissimilarity coefficients. Such coefficients were more wide in "Giza 76" rather than in "Giza 45". Moreover, dissimilarity coefficients between full fuzz offtype and its F_1 progenies were only significant in “Giza 76”, indicating a wide distances between them. This trend was not pronounced in “Giza 45”. However, the dissimilarity coefficients between the naked seed offtype of “Giza 45” as well as the white flower offtype of “Giza 76” and their F_1 progenies were insignificant showing their close relationship. These results assured that the naked seed-Creamy lint offtypes were wide divergent than their progenies as well as than their original parents, “Giza 45” and “Giza 76”.

Table 4: Squared Euclidean dissimilarity coefficients between the offtypes and their derived F_1 progenies.

Crosses	1- Offtypes of Giza 45 and their F_1's		
	N.	N.C	F.F
Straight F_1	5.4279	17.5649*	12.8390
Reciprocal F_1	7.9033	22.8865*	6.0295
	2- Offtypes of Giza 76 and their F_1's		
	W.F	N.C	F.F
Straight F_1	12.3663	39.4853*	15.8206*
Reciprocal F_1	10.7510	47.6002*	21.0808*

*** Significant at 0.05**

3.Clustering pattern:

The studied cotton genotypes, parents and F_1 crosses in both “Giza 45” and “Giza 76” varieties were subjected into clustering analysis based on Euclidean distances between them. The clustering pattern of these genotypes are graphically illustrated as dendrograms, tree diagram, in Figure 4. Such linkage dendrograms could provide visual idea about clustering and variability present in each cotton population.

Based on the extent of relative dissimilarity among genotypes and on the basis of yield and lint studied characters, the ten genotypes, four parents and their six F_1 hybrids, were grouped into four clusters either among “Giza 45” or “Giza 76” genotypes (Figure 4). In this regard, Sandhu and Boparai (1997) grouped some arboreum genotypes into 12 clusters, using multivariate analysis. But, Khedr (1998) classified some barbadense genotypes into three major clusters using Euclidean distance method.

The distribution of genotypes into clusters are given in Table 5. The clustering pattern indicated that there was inconsistent relationship between the parental genotypes and their F_1 hybrid performances. The parental offtypes were distributed into three clusters, only full fuzz offtype of “Giza 45” was combined with its original genotype “Giza 45” and their F_1 hybrids in the same cluster, cluster I. This cluster, I, was the largest one, in both varieties, and included four members in “Giza 45” and five members in “Giza 76”. The original genotypes, as common parents, were not completely grouped with all their F_1 progenies in one cluster. For instance, cluster I of “Giza 76” grouped only four, out of six, F_1’s with their common parent in the same cluster. Cluster II included only both full fuzz seed and white flower offtypes of “Giza 76”, but it included the naked seed offtype and F_1 progenies among “Giza 45”, while cluster III consisted only of F_1 hybrids, straight and reciprocal crosses, descendants of naked-creamy offtypes in both varieties. It could be concluded that might considerable divergence could be created by hybridization, since F_1 hybrids were widely dispersed from their parents.

Table 5: Distribution of studied cotton genotypes into clusters.

Cluster No.	No. of genotypes in clusters	Members of each cluster
1- Giza 45 genotypes		
I	4	G.45, F.F, G.45 x F.F, F.F x G.45
II	3	N., G.45 x N, N x G.45
III	2	G.45 x N.C, N.C x G.45
IV	1	N.C
2. Giza 76 genotypes		
I	5	G.76, G.76 x F.F, G.76 x W.F, F.F x G.76, W.F x G.76
II	2	F.F, W.F
III	2	G.76 x N.C, N.C, X G.76
IV	1	N.C

The naked creamy offtype, in both varieties, constituted a single cluster (cluster IV) having wide divergent distance from all the other genotypes. In this regard, Amudha *et al*. (1997) found wide divergence among coloured, green and brown, lint genotypes and white linted varieties as distributed into separated clusters.

Data in Table 6 illustrated cluster means of the eight studied characters, involved in Euclidean clustering analysis, for each cluster. cluster I characterized by its high lint quality with a moderate yield potentials, however cluster IV exhibited the opposite trend. Cluster II and cluster III tend to behave in their characterization, more or less, as cluster I and cluster IV, respectively.

Table 6: Cluster means of the contributed characters in each cluster.

Cluster No.	The studied characters							
	SCY	LP	LI	S/B	FF	Rd	+ b	SL 2.5 %

1- Giza 45 genotypes								
I	5.75	32.64	3.74	15.15	9.61	56.44	18.79	32.70
II	7.59	34.80	3.97	18.20	11.42	57.38	18.14	33.70
III	7.62	34.40	3.96	18.40	10.99	54.25	20.13	32.80
IV	8.12	34.84	3.96	18.20	11.73	51.80	21.44	29.50
2- Giza 76 genotypes								
I	6.20	35.24	3.87	15.60	10.13	57.63	17.95	33.78
II	5.81	34.27	3.81	15.05	9.94	54.12	18.55	32.25
III	7.18	34.14	3.77	21.85	10.66	54.84	19.29	30.90
IV	7.61	33.00	3.69	21.40	11.81	49.40	21.72	28.80

These results might reflect the important contribution of lint quality characters in the relationship between original genotypes and their offtypes. Consequently, genetic divergence among these cotton genotypes was clearly exhibited in terms of cluster means for lint quality characters rather than lint yield which agreed with findings of Sambamurthy *et al*. (1995a and b).

Generally, the results of principal components analysis and clustering analysis appeared to be in complete accordance. The application of both analysis seemed to look reasonably straight forward. Cluster analysis could efficiently describe the characteristics of groups of genotypes, however, the components analysis could provide no clear grouping but give a special representation of each mode.

Both of the cluster and principal components analysis gave a sensible and useful integration of the data. Considerable interpretations were available through the complementary use of both methods in examining the relationship among clusters as well as the variation within cluster. Also, these methods were successfully integrated the yield and lint quality data. The analyses pointed out to a decision in favor of either high yield with low quality lint or moderate yield but superior lint quality.

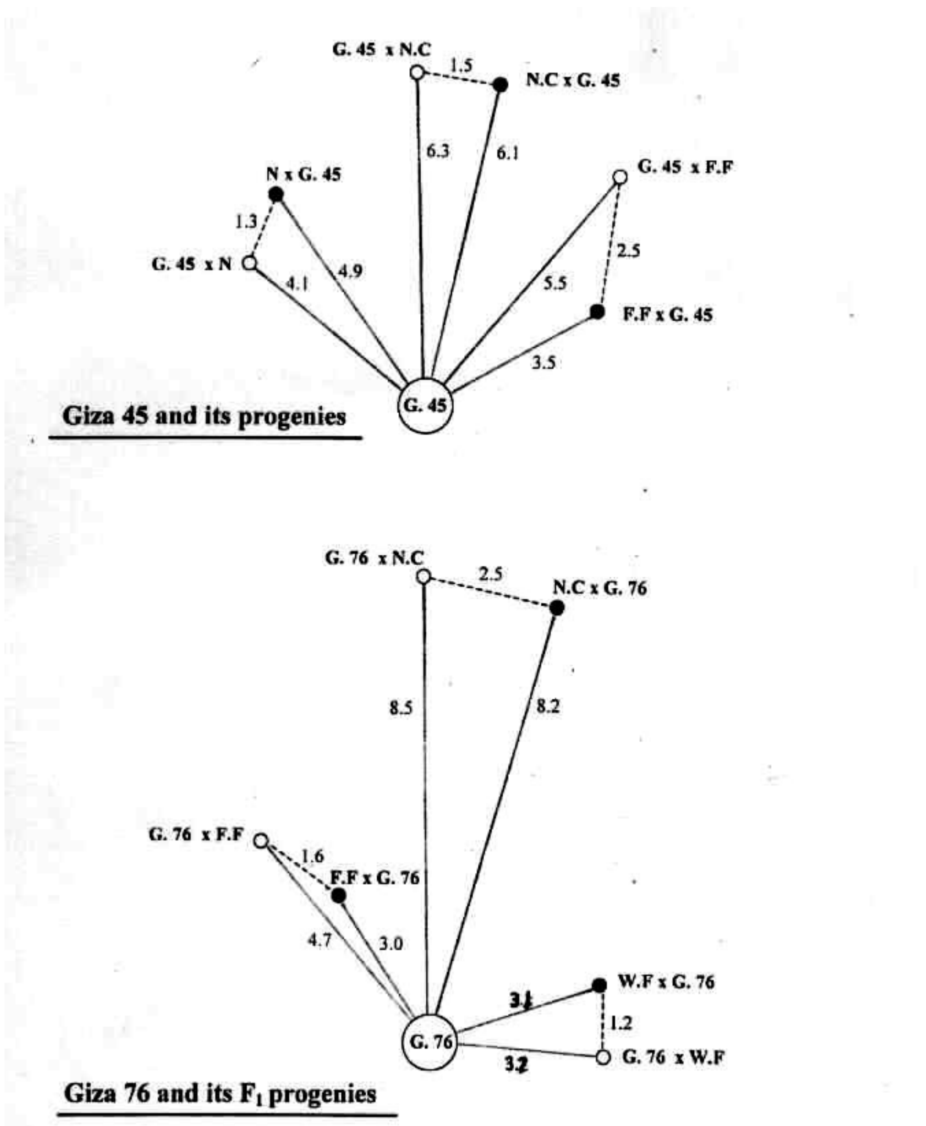

Figure 6 : Genetic divergence distances among the original genotypes and their F_1 progenies .

○ **Straight crosses** ● **Reciprocal crosses**

Genetic divergence distances among the original genotypes and their F_1 progenies

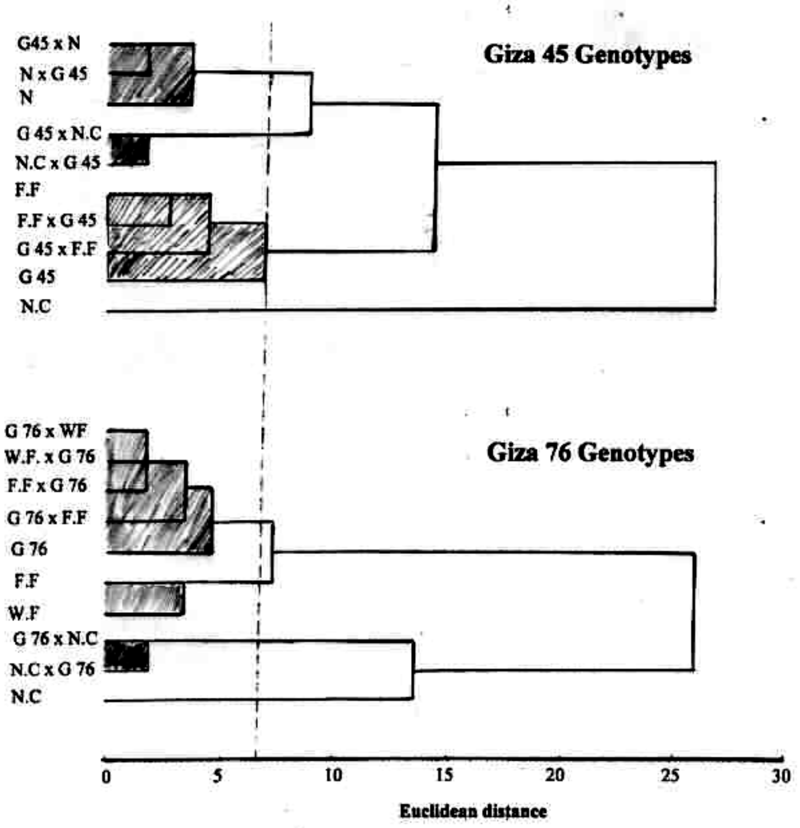

Fig. 4: Dendrogram presentation of studied cotton genotypes in clustering pattern

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دراسات وراثية على الطرز المغايرة لبعض الأقطان المصرية

1- التباعد الوراثى بين التراكيب الوراثية

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أجرى هذا البحث بمحطة البحوث الزراعية بسخا خلال موسمى نمو 1997 ، 1998 واستخدم فى هذه الدراسة صنفين من القطن المصرى هما جيزه 45 ، جيزة 76 وهما يتبعان *G. barbadense* L. مع الثلاث طرز المغايره المستحدثة تلقائيا لكل صنف.

ويمكن تلخيص النتائج المتحصل عليها كما يلى:

1- أوضح تحليل المكونات الأساسية (Principal components analysis) أن المكونات الأربعة الأولى تمثل حوالى 95% من التباين الكلى على مستوى جميع الصفات بينما يمثل المكون الأول حوالى 60% ، 73% من التباين بين التراكيب الوراثية لكل من جيزه 45 ، جيزه 76 على التوالى.

2- كانت صفة محصول القطن الزهر/نبات يليها معامل الشعر الأكثر مساهمة فى التباعد الوراثى بين التراكيب الوراثية لصنف جيزه 45 بينما ساهمت صفة اللون (درجة الاصفرار ونسبة الانعكاس) بقدر أكبر فى التباعد الوراثى بين التراكيب الوراثية لصنف جيزه 76 مما يعكس إختلاف التركيب الوراثى بكلا الصنفين.

3- أوضح التباعد الوراثى على أساس Euclidean distance أن الطراز "عارية - كريمى" كان أكثر تباعدا عن الآباء الأصلية والطرز المغايرة الأخرى والتى كانت أقل تباعدا حيث أظهر قدر اكبر من عدم التشابة.

4- كان معامل عدم التشابه (Dissimilarity coefficients) غير معنوى بين الهجن العكسية فى كلا الصنفين مما يوضح وجود قرابة وراثية ويؤكد غياب أى تأثيرات أمية على التباعد الوراثى.

5- اظهر الطراز المغاير "بذرة عارية شعر كريمى" تباعد وراثى واضح عن الجيل الاول (الامامى والعكسى) وذلك يظهر من معنوية معامل عدم التشابه كذلك وجد أن هذا المعامل أكبر فى صنف جيزة 76 عن صنف جيزة 45.

6- تم وضع التراكيب الوراثية العشرة لكل صنف (4 آباء + 6 هجن) تحت أربع مجاميع سواء بالنسبة لصنف جيزه 45 أو صنف جيزه 76 وذلك على أساس عدم التشابه النسبى بينهم.