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ASSESSMENT OF GENETIC VARIATION AMONG TWO COTTON VARIETIES GIZA 80 AND GIZA 83 WITH THEIR OFF-TYPES

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ABSTRACT

The two Egyptian cotton varieties Giza 80 and Giza 83 were cultivated in a large scale of Middle and South Valley, respectively. "Recently, area of G. 83 gradually is shrunk". Several observable off-type plants, which cause reduction in yield and inferior in fiber-quality, were characterized, grouped and evaluated throughout three successive seasons at Sids Agricultural Research Station. This investigation was conducted to gain insight into genetic variability between the standard types and their off-type patterns. The results showed that the differences among G. 80 and G. 83 with their off-type patterns were mainly, affected by two factors. The first one was attributed to the cultivars and their off-type groups, while the second factor concerned the ability of characters that might exhibit discrimination. Canonical discriminant analysis revealed that the lint percentage character showed highest discrimination among studied varieties and their off-type groups. The other discriminant traits; lint index, seed index, boll weight, micronaire value and pressely index gave unconventional behavior according to the cultivar. While, seed cotton yield/plant, lint yield/plant, boll number and number of seeds/boll characters exhibited minor effect, so that they might not be used as indicator for genetic differentiation among studied genotypes. The squared distances (D^2) between G. 80 and both of G. 80 T1 (dark creamy lint naked seeds) and G. 80 T2 (light creamy lint tufted seeds) were highest than the other two off-type groups, indicating the mixture by these off-type seeds in some general farms of G. 80. With respect to G. 83 and its off-type groups, G. 83 T1 (white lint-naked seeds) exhibited longer genetic divergence comparable to the others.

INTRODUCTION

Yield and lint characters of cotton are considered the main proprieties in the cotton production and industry. Homogeneity and uniformity of such characters represent the practical criteria for identification and judging the purity of the cotton cultivars. However, cotton cultivars production in the general farms, might be, mistakenly, mixed by strange seeds or out-crossed by different genotypes, consequently changes in the homogeneity and uniformity and eventually some off-type plants are spontaneously induced. The off-types are inferior cotton plants exist occasionally among commercial cotton varieties throughout the long period of their culture. The importance of this study as one of the main research point in the maintaining genetic purity among cotton genotypes was to recognized and study the off-type cotton plants, in which offer information of protection against degeneration of yield potentials and fiber quality. Hattab *et al.* (1962), Abdel-Bary and Bisher (1962) and (1965) classified and studied the off-type cotton plants according to the seed fuzz type. They estimated the percent of foreign seeds among standard type and recorded their characters. The lint discoloration of Egyptian cotton varieties were also studied, by several workers; Al-Didi (1984), El-Shazly (1987) and Kamal *et al.* (1988). They found that the dicolored cotton was associated with deterioration in fiber quality and lower yield components. El-Okkia *et al.* (1990) studied the variation between the standard type of Giza 70 its off-type (Giza 70 brown locks). They concluded that the Egyptian cotton varieties including off-type cotton locks would cause lack of color uniformity, depression of yield and quality, reduction of yarn strength and increment of waste in spinning processes. Hemaida (2000) studied the differences among the standard types of Giza 80 and Giza 83 with their off-type plants, using analysis of variance. He indicated that the off-type plants of Giza 80 gave considerably lower values for boll weight, lint percentage, seed index, lint index and fiber strength characters, while the discoloration type of Giza 83 exhibited later maturity and coarser fiber compared to the standard type.

However, Univariate statistical techniques such as analysis of variance do not explain how accessions differ when all measured variables are considered jointly. However, by using the multivariate statistical technique, all variables are considered simultaneously in the differentiation of populations. This approach results in a more powerful comparison of populations than could be achieved with Univariate analysis. In canonical discrimination analysis, a multivariate statistical technique, all independent variables (traits) are considered in the discrimination of populations (genotypes). It extracts components so that the among population variability (genetic) is maximized compared with the within-population (environmental) variability. Therefore, canonical discrimination analysis can separate among-population effects from within population effects (Vaylay and Van Santen, 2002 and Yeater *et al.* (2004). Essentially, it maximizes the overall heritability of canonical varieties and places very large weight on traits with low levels of environmental variability (Vaylay and Van Santen, 2002). After extraction of among population variability (genetics), the genetic differentiation between populations could be measured by the squared distance (D^2) statistic as outlined by McElory *et* al.(2002)and Gutierrez *et al.* (2003). The main objectives of this investigation were to characterize and evaluate the variation, as well as to estimate the genetic distances among the standard types of Giza 80 and Giza 83 with their off-type groups, by using analysis of variance and canonical discriminant analysis.

MATERIALS AND METHODS

This investigation was carried out in three successive growing seasons 2002, 2003 and 2004. In 2001 growing season, several samples of off-type plants of Giza 80 and Giza 83 were harvested from different general farms,. In 2002 season, the off-type plants were cultivated in experimental farm at Sids Agricultural Research Station in Beni Suef Governorate. During the two growing seasons 2002-2003, and according to the field characterization, seed type and lint color, selection and artificially self-pollination were applied to group off-type patterns of G. 80 and G. 83. The descriptions of off-type groups as well as the standard cultivars were recorded in Table 1. In 2004 season, the off-type patterns and their controls; foundation seeds of G. 80/2004N and G. 83/2004N, were included in a randomized complete blocks design with three replications. Each plot contained two rows;

the row was four meters long, 60 cm, apart and 10 hills per row. The hills were thinned to one plant. All agricultural practices were applied according to the recommendations.

Table 1: Characteristics of the studied materials showing the standard type of G. 80 & G. 83 cultivars and their off-type patterns.

Genotypes	Abbreviation	Characteristics
G. 80/2004 N (control)	G. 80	The plant height ranged from 130-145 cm. Leaves are shiny green, lob are wrapped up with 2-3 nectar glands at the lower surface. The bolls are shiny green, large size, conical shape and 3 nectar glands at the base of bracts. Large tufted brown seeds. Dark creamy lint.
G. 80 off-type (1)	G. 80 T1	The plant height ranged from 200-250 cm. The leaves have noticeable large area and flatted lobs with 1-2 nectar glands at the lower surface. Small global bolls without nectar glands at the base of bracts. Small, naked, black and thorny-top seeds. dark creamy lint.
G. 80 off-type (2)	G. 80 T2	The plant height ranged form 200-250 cm. Large leaf area, flatted lobs with 2-3 nectar glands at lower surface. Small bolls 0-1 nectar gland at the base of bracts. Small, naked to tufted seeds. Light creamy lint.
G. 80 off-type (3)	G. 80 T3	The plant height ranged form 150-180 cm. The leaves have normal area with 2-3 nectar glands at the lower surface. Large bolls, with 2-3 nectar glands at the base of bracts. Completely fuzzy seeds. Creamy lint.
G. 83/2004 N (control)	G. 83	The plant height ranged from 115-130 cm. The leaves are dingy green, small area, the lobs are wrapped up, 2-3 nectar glands at the lower surface. Small global bolls with tit at the tip, no nectar glands presented at the base of bracts. Small seeds, about the 1/4 seed area are covered by white fuzz. Lint color is light creamy
G. 83 off-type (1)	G. 83 T1	The plant height ranged from 150-180 cm. The leaves are larger than G. 83 and has 1-2 nectar glands at the lower surface. Conical bolls with 1-2 nectar glands at the base of bracts. Dark brown naked seeds. Lint color is white.
G. 83 off-type (2)	G. 83 T2	The plant height ranged form 130-150 cm the leaves are larger, and both the leaves and bolls are shiny green. 2-3 nectar glands are present at the base of bracts. Seeds are naked. The lint color is dark creamy.
G. 83 off-type (3)	G. 83 T3	The plant height ranted from 120-130 cm. The leaves are normal but shiny green with 1-2 nectar glands at the lower surface. Conical shiny green bolls with 3 nectar glands at the base of bracts. completely to 3/4 fuzz covered seeds. The lint color is light creamy.

Data analysis:

In 2004 season, a representative sample of ten guarded plants of each type as well as the control were chosen in each plot to estimate, seed cotton yield/plant (SCY), lint yield/plant (LY), boll number (BN), boll weight (BW), lint percentage (LP), seed index (SI), lint index (LI) and number of seeds/boll (SB). The micronaire value (MIC) and Pressley index (PI) traits were measured as individual plants in Cotton Technology Research Dep.

Analysis of variances were conducted according to the Snedecor and Cochran (1981). Also, canonical discriminant analysis was used for data analysis, Hair *et al.* (1987). Canonical discriminant analysis facilitates differentiation of groups by taking into account the interrelationships of the independent variables (traits) and the dependent variables (genotypes). An important property of canonical variables is that they are uncorrelated even though the underlying quantitative variables may be highly correlated. Canonical discriminant analysis is a very powerful tool in determining genetic distances among the genotypes. Three and two canonical functions were derived for differentiation among the standard types and their off-type populations (genotypes). The mean value of the canonical discriminant function is referred to as group centroid. The difference between centroid values of two groups is the D^2 distance and is calculated as:

$$D^2 = (\overline{X}_1 - \overline{X}_2)' S^{-1} (\overline{X}_1 - \overline{X}_2)$$

Where, $\overline{X}_1$ and $\overline{X}_2$ are the estimated mean vectors in the respective groups, and S^{-1} is the inverse of the pooled sample variance-covariance matrix (Dillon and Goldstein, 1984). All these computations are performed using Minitap V. 12.1 (1998) and SPSS 7.5 (1996) computer programs.

RESULTS AND DISCUSSION

Significant differences among G. 80 and its off-type plants were observed for all studied characters except number of seeds/plant as observed from Table 2. The data showed that the G. 80. surpassed G. 80 T1 for most studied characters with exception of seed index. While, the second off-type group G. 80 T2 was significantly differed form the standard type G. 80 for boll weight, lint percentage, lint index, micronaire value and Pressley index characters. On the other hand, no significant differences were detected between G. 80 and the third type G. 80 T3 for all studied traits, meanwhile, that the classification of G. 80 and the third off-type pattern due to the characteristics of the seed type and lint color may be unaffected on the studied characters, therefore, the requirement for more traits to be studied should be fulfilled. Regardless the forth type G. 80 T4 comparable with G. 80, significantly differences were observed for boll weight and Pressley index. It could be concluded that the source of G. 80 T1 and G. 80 T2 types which remarkably differed from the standard type G. 80 for most studied characters, might be a result of mixture by impure (strange) seeds, while the G. 80 T3 and G. 80 T4 which exhibit slightly differences from the standard type, might be due to a late segregation of out-crossing with impure seeds or effect of mutation.

The results in Table 3 indicated that there was not any significant differences detected among G. 83 and its off-type groups for seed cotton yield/plant, lint yield/plant, boll number/plant and number of seeds/boll characters. However, G. 83 exhibited significant differences from G. 83 T1 and G. 83 T2 for lint percentage, lint index, seed index, micronaire value and Pressley index, while, the differences between G. 83 and G. 83 T3 were observed for boll weight, lint percentage, seed index and Pressley index. It could be concluded that the seed cotton yield, lint yield, boll number and number of seeds/boll are not the distinctive traits among G. 83 and its off-type plants. On the contrary, lint percentage, seed index and Pressley index might be considered as distinguishable characters, while, boll weight, lint index and micronaire value partially differed G. 83 from its off-type groups.

Table 2: Mean performances comparison of G. 80 and its off-type groups for all studied characters.

Genotypes / Traits	G. 80	G. 80 T1	G. 80 T2	G. 80 T3	G. 80 T4
SCY (gm.)	42.02 ab	18.20 c	37.28 bc	58.31 a	42.32 ab
LY (gm.)	16.61 ab	5.35 c	12.92 b	23.20 a	16.68 ab
BN	12.7 ab	7.0 b	12.9 ab	18.3 a	11.8 ab
BW (gm.)	3.3 b	2.7 c	2.9 c	3.2 b	3.6 a
LP%	39.6 a	29.4 c	34.4 b	40.0 a	39.5 a
LI (gm.)	7.7 a	5.1 c	6.0 b	7.9 a	8.3 a
SI (gm.)	11.8 ab	12.1 ab	11.4 b	11.8 ab	12.7 a
SB	17.0	15.8	16.9	16.2	17.0
MIC	4.4 c	5.1 ab	5.4 a	4.6 c	4.8 bc
PI	9.6 a	8.6 c	8.4 c	9.5 a	9.1 b

Table 3: Mean performances comparison of G. 83 and its off-type groups for all studied characters.

Genotypes / Traits	G. 83	G. 83 T1	G. 83 T2	G. 83 T3
SCY (gm.)	46.73	46.12	42.56	52.07
LY (gm.)	19.83	16.19	16.32	20.6
BN	14.9	13.7	13.9	15.1
BW (gm.)	3.2 b	3.3 ab	3.1 b	3.5 a
LP%	42.4 a	34.9 d	37.9 c	39.8 b
LI (gm.)	7.7 a	6.8 b	6.9 b	7.9 a
SI (gm.)	10.5 c	12.6 a	11.3 b	12.2 a
SB	17.4	17.3	17.1	17.1
MIC	4.3 b	4.7 a	4.8 a	4.2 b
PI	9.6 a	8.8 c	9.1 b	9.1 b

It could be concluded from the results of Tables 2 and 3 that the differences among G. 80 and G. 83 with their off-type patterns were mainly, affected by two factors; the first one was attributed to the cultivars and their off-type groups and the second factor was concerning the ability of characters that might exhibit discrimination. Many workers studied the inferior effect of off-type cotton plants among Egyptian cotton cultivars; El-Shazly (1987), Kamal *et al.* (1988), El-Okkia *et al.* (1990), Abo-Arab *et al.* (2000) and Hemaida (2000), they stated significantly differences among standard varieties and their off-type plants for different traits. However, there is need to know which character/s (variables) could discriminate between the studied genotypes (groups), also, to find a way to measure the distances between the standard types and their off-type patterns. For these purposes, discriminant function analysis was used in this part of the investigation. Whereas, the Univariate statistical techniques like analysis of variance does not show how cultivars differ when all variables are considered together. Canonical discriminant analysis simultaneously examines differences of the variables and indicates the relative contribution of each variable to genotype discrimination. Multivariate procedures also, based on the studied characters have been used in the assessment of genetic divergence among different genotypes.

Concerning G. 80 and its off-type groups, the first three canonical functions were significant (P < 0.0001) and accounted for 98.4% of the among groups variance (genotypes) as regarded from Table 4. Each canonical function is the linear combination of the independent variables (characters) and its orthogonal to the other. Canonical correlation measures the strength of the overall relationships between the canonical discriminant functions and genotypes sets of variables. The significant canonical correlation between the genotypes and both of the first, second and third canonical function (r = 0.94, 0.73 and 0.68), respectively, indicates that the canonical function can explain the differentiation of the genotypes. Canonical loading measures the simple linear correlation between an original independent variable (trait) and the canonical function. Thus, the canonical loading reflects the variance that the observed variable shares with the canonical function and could be interpreted in assessing the relative contribution of each variable to each canonical function (Hair *et al.*, 1987). The first canonical discriminant function which represents 77.5% of the total variance among genotypes is dominated by a large loading from lint percentage followed by lint index, the second function is dominated by a large loading from micronaire value followed by Pressley index and the third function is dominated by a large loading from seed index followed by boll weight.

Table 4: The canonical loadings of the independent variables on the first three canonical discriminant functions of Giza 80 and its off-type groups.

Traits*	Canonical discriminant functions		
	1	2	3
Lint percentage	0.793	0.230	0.147
Lint index	0.657	0.112	-0.347
Micronaire value	-0.331	0.601	0.013
Pressley index	0.318	-0.464	0.323
Seed index	0.043	-0.059	-0.615
Boll weight	0.359	0.187	-0.588
Lint yield/plant	0.260	0.082	0.341
Seed cotton yield/plant	0.204	0.0107	0.334
Boll number/plant	0.113	0.100	0.462
Number of seeds/boll	0.045	0.161	-0.096
Eigen value	7.441	1.140	0.858
Canonical correlation	0.939	0.730	0.680
P level of significance**	HS	HS	HS
% of variance	77.5	11.9	9.0
Cumulative variance	77.5	89.4	98.4

*** Variables ordered by absolute size of correlation within function**
**** HS = High significant (P < 0.001)**

Thus, it is evident that the genetic composition of the five groups (G. 80 and its off-types) chiefly differed in lint percentage, lint index, micronaire value, Pressley index, seed index and boll weight. With respect to the G. 83 and its off-type patterns, the first two canonical functions were significant ($P < 0.0001$) and accounted for 96.9% of the among group variances as shown in Table 5. Significant canonical correlation between the genotypes and the first canonical function (r = 0.904) and genotypes and second canonical function (r = 0.80) proves that the canonical functions could illuminate the discrimination of the genotypes. The variances explained by the first and second canonical discriminant function were 69.3 and 27.6%, respectively. In the same time, lint percentage had highest loading in the first canonical function followed by seed index and Pressley index. On the second discriminant function, micronaire value had the highest influence followed by lint index and boll weight.

Table 5: The canonical loadings of the independent variables on the first two canonical discriminant functions of Giza 83 and its off-type groups.

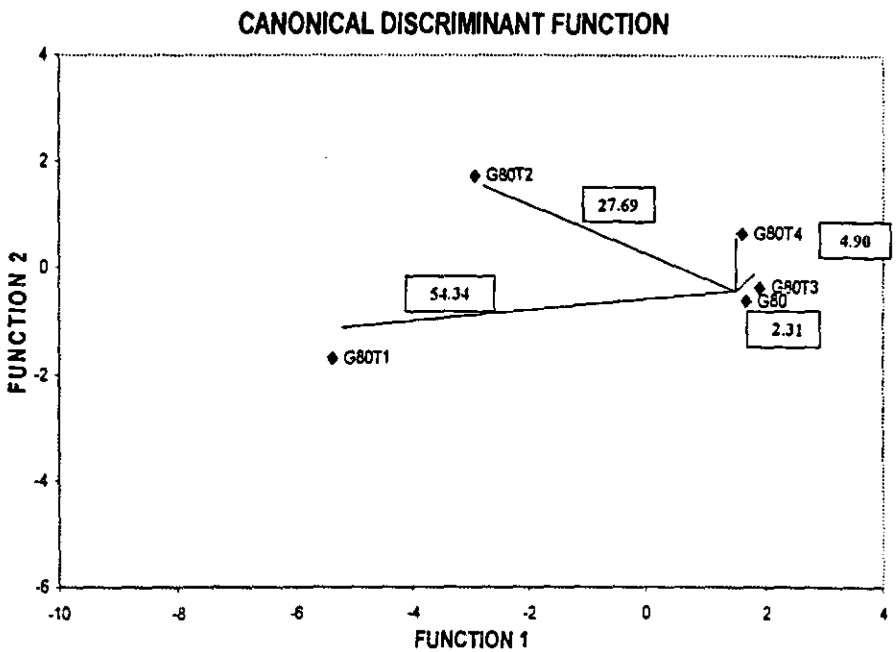
Traits*	Canonical discriminant functions	
	1	2
Lint percentage	0.682	-0.259
Lint index	-0.633	-0.385
Micronaire value	0.221	-0.010
Pressley index	-0.205	0.629
Seed index	0.213	-0.417
Boll weight	-0.134	-0.352
Lint yield/plant	0.097	-0.187
Seed cotton yield/plant	0.005	-0.151
Boll number/plant	0.042	-0.070
Number of seeds/boll	0.013	0.009
Eigen value	4.457	1.776
Canonical correlation	0.904	0.800
P level of significance**	HS	HS
% of variance	69.3	27.6
Cumulative variance	69.3	96.9

* Variables ordered by absolute size of correlation within function

** HS = High significant ($P < 0.001$)

It could be concluded that lint percentage character showed highest discrimination among studied varieties and their off-type groups. The other discrimination traits; lint index, seed index, boll weight, micronaire value and Pressley index gave unconventional behavior according to the standard cultivar and its off-type groups. While, seed cotton yield/plant, lint yield/plant, boll number and number of sees/plant exhibit minor effect, so that they might not be used as indicator for genetic differentiation among studied genotypes.

The centroid values for the first two canonical discriminant functions for G. 80 and G. 83 and their off-type patterns were plotted Fig. 1. The extent of divergence of genotypes was measured by squared distance D^2. All distances between standard varieties and their off-type groups were significant ($P < 0.05$).



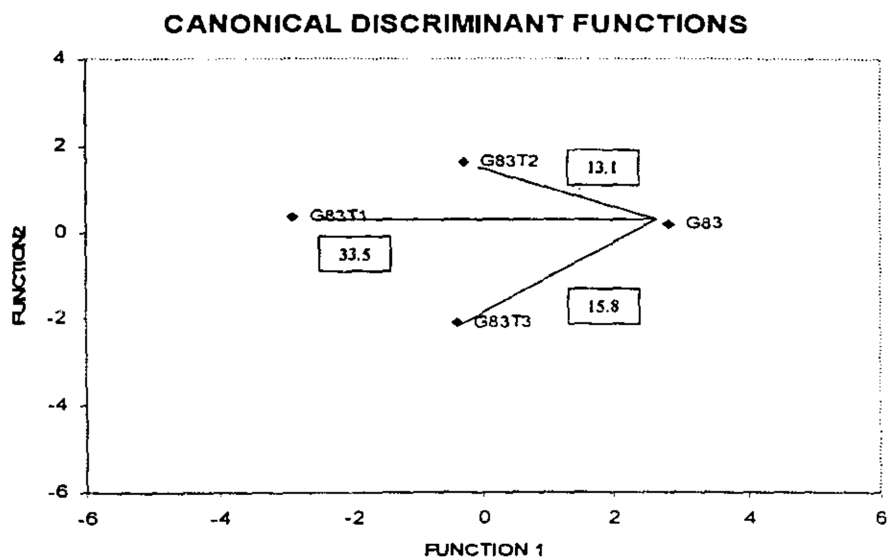


Fig. 1: Scattarplot of centroid values on the two canonical discriminant functions. Mahalanobis squared distances measures the extent of genetic diversity among G. 80 and G. 83 and their off-type groups.

The distance between G. 80 and G. 80 T3 was only 2.314 but, was nevertheless significant ($P < 0.002$), G. 80 and G. 80 T3 were, somewhat, exhibited the same morphological and similar characters except for boll weight and Pressley index traits as shown in Table 2. On the other hand, the squared distances between G. 80 and both of G. 80 T1 and G. 80 T2 were high; 54.34 and 27.69, respectively. These two off-type patterns significantly differed from G. 80 for lint percentage, lint index, micronaire value and pressely index (Table 2). The same traits that gave the highest canonical loading as described in Table 4. These findings reflected the high genetic divergence of G. 80 T1 and G. 80 T2 from the standard type G. 80 and ensure the mixture occurrence by these off-type seeds in some general farms of G. 80. With respect to G. 83 and its off-type groups, G. 83 T1 exhibited longer genetic divergence 33.55 comparable to the other off-type groups (13.16 and 15.80 for G. 83 T2 and G. 83 T3, respectively). The G. 83 T1 significantly differed form the standard type for lint percentage, lint index, seed index, micronaire value and Pressley index (Table 3), the traits which showed the highest canonical loading as shown in (Table 5).

It could be concluded from the previous results that the genetic variation among standard and their off-type populations could be determined. Abdel-Sayyed *et al.* (1998) studied the genetic divergence among seven varieties belong to *G. barbadense*. They clustered them into three major groups based on Euclidean distances. Abdel-Sayyed *et al.* (2000) estimated the genetic divergence among Egyptian cotton varieties G. 45, G. 76 and their off-types. They revealed that the (naked seed-creamy lint off-type) in both varieties, was wide divergent from their original types.

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تقييم التباين الوراثى بين صنفى القطن جيزه ٨٠ وجيزه ٨٣ والطرز المغايرة لهما

جابر محمد خليل حميده ــ محمد عبدالحكيم على نجيب ــ جمال حسين عبدالظاهر
معهد بحوث القطن – مركز البحوث الزراعيه – الجيزه

أجرى هذا البحث بمحطة بحوث سدس فى ثلاث مواسم متتالية ، وهذه المواســم هــى ٢٠٠٢ ، ٢٠٠٣ ، ٢٠٠٤م حيث تم جمع بعض النباتات الغريبة من الزراعات العامة بالوجه القبلى موسم ٢٠٠١ ثم زراعتها فى حقل منعزل بالمحطة وتم توصيف النباتات خضريا وكذلك وصــف البذور ولون الشعر ، وقد أمكن بالإنتخاب والتلقيح الذاتى تقسيم هذه الطرز تبعا لــصفات البــذور ولون الشعر إلى مجموعات متميزة من نماذج الطرز المغايرة حيث كان عددها أربع مجموعــات لصنف جيزه ٨٠ وثلاث مجموعات لصنف جيزه ٨٣ ، وفى موسم ٢٠٠٤م أجريت تجربة لمقارنة الأصناف النقية بطرزها المغايرة فى تجربة قطاعات كاملة العشوائية فى ثلاث مكــررات. وقــد أظهرت نتائج تحليل التباين وجود فروق معنوية بين معظم الصفات محل الدراسة توقفــت علــى عاملين أساسيين: العامل الأول: هو عامل الصنف حيث كان التباين بين جيزه ٨٠ والطرز المغايرة له للصفات محل الدراسة تختلف عن التباين بين جيزه ٨٣ والطرز المغايرة له ، والعامل الثــانى: هو ترتيب الصفات من حيث قدرتها على إظهار التمييز بين الأصناف.

وباستخدام طريقة تحليل التمييز Discriminant analysis أمكن ترتيب الصفات تبعا لقدرتها على التمييز بين التراكيب الوراثية المختلفة ، وكذلك تقدير درجة التباعد الوراثى بين كــل صنف وطرزه المغايرة. وقد أظهرت النتائج أن صفة معدل الحليج كانت أكثر الصفات تمييزا فــى كلا الصنفين مع الطرز المخالفة لهما ثم اختلف الترتيب بعد ذلك لباقى الــصفات تبعــا للــصنف والطرز المغايرة له. وبدراسة التباعد الوراثى وجد أن التباعد بين جيزه ٨٠ والطراز ذو الــشعر الداكن والبذور العارية (جيزه ٨٠ ، طــ١) كان أكبر ما يمكن بينما فى جيزه ٨٣ كــان التباعــد الوراثى بينه وبين الطرازز ذو الشعر الأبيض والبذور العارية (جيزه ٨٣ ، طــ١) أكبر ما يمكن ، وهذا يدل على أن هذه الطرز قد تكون أتت نتيجة لحدوث خلط ببذور غريبة عن الصنف.