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GENETIC POLYMOPHISM FOR INSECTS RESISTANCE ATTRIBUTES IN SOME COTTON GENOTYPES : LEAF SHAPE CHARACTERISTICS

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ABSTRACT : This study was conducted to study the genetic morphological polymorphism for some insects resistance attributes, leaf shape characters, using principal components analysis among cotton genotypes .For this purpose, two cotton varieties, Giza 83 and Giza 85, and the American strain "Nectariless-Okra leaf "as well as their F1's, obtained from crossing Giza cottons as female parents with the American strain,were examined besides their derived BC_4 progenies. The "Nectariless-Okra" strain varied significantly in all leaf shape parameters compared with both Giza cottons, but F_1's plants exhibited some sort of intermediate scores. Most of BC_4 progenies in both crosses showed various scores of leaf shape measurements, some progenies were similar to their Giza parent and the others were near to "Nectariless-Okra leaf" strain. The principal components, PC, analysis revealed that leaf width and leaf area were primary sources of variation and eventually polymorphism, having the highest eigen coefficient in the first PC axis among progenies of both crosses. The second PC axis separated "Nectariless-Okra leaf" strain from both Giza parents and their F_1's. Most of BC_4 progenies in both crosses were near to their common parent, assuring the role of selection for choosing "Nectariless-Okra Leaf" characteristics in backcross generations. These results reflected a visual non-numeric grasp of the amount of genetic polymorphism existing among cotton materials under consideration.

INTRODUCTION

Cotton plants resistance to insects may be due to one or more plant characteristics; morphological, physiological or biochemical; distinguishing a variety from another. The multiplicity of resistance mechanisms can influence the ultimate degree of plant damage by insects (Norris and Kogan, 1980).
Cotton plants with leaves having identations deeper than normal between lobes are known "okra – leaf" genotypes. Okra-leaf, Lo2Lo2, is considered a leaf shape morphotype that alter leaf shape by increasing length of lobes and decreased lamina expansion comparing with normal cotton leaf, lo2lo2, shape (Jones, 1982).
Okra-leaf genotypes are proved to be new sources of host-plant resistance to cotton insects (Wilson, 1989; Zhang *et.al.*1993; Wu *et.al.* 1997 and Chu *et.al.* 2000 and 2001).
The present work aimed to study genetic polymorphism, at morphological level, of cotton leaf shape as insect resistance attribute, using two cotton crosses involved the " Nectariless-Okra " strain as common parent, in the parental genotypes, F1, s and their derived BC4 progenies.

MATERIALS AND METHODS

Two Egyptian cotton varieties, Giza 83 and Giza 85, belonging to *Gossypium barbadence*, L. and the American, *G.hirsutum*, strain "Nectariless-Okra leaf" were used in this study as parental genotypes. Selfed seeds of the three parents were planted in the season of 2001 and interspecific crossing was done using Giza cottons as females . In the season of 2002, the seeds of the two interspecific F_1, s along with selfed seeds of their parents were sown in a complete randomized experimental design with three replicates. Each replicate comprised five rows; one for each entry or BC_4, each row contained ten plants. The study was also included the " BC_4 " progenies derived from backcrossing F_1 of both crosses to their corresponding Giza parents, which were obtained from the cotton-breeding program of the Cotton Research Institute. The seeds of the two BC_4 progenies to Giza 83 and to Giza 85 were also sown in the same season, 2002. Each backcross represented by three rows, each contained ten plants. Normal culture practices were applied as recommended for ordinary cotton cultivation. The investigation was carried out at the Department of Cotton Breeding, Cytology and Genetics Unit, Cotton Research Institute, Agriculture Research Center, Giza. Data were taken on leaf samples of twenty four leaves collected from twelve plants. The upper fourth and fifth leaves were picked of each entry; parent, F1 or BC_4 at 70 days old. The following leaf shape parameters were examined in cm.: middle lobe ,length, leaf width, lobbing depth, degree of lobbing (lobe length/lobe depth) and leaf shape index (lobe length/leaf width). Leaf area (cm2), leaf thickness (mm) and leaf dry weight % were also estimated. All leaf-shape parameters were statistically analysed on plot mean basis . The original data of leaf area and leaf dry weight % were transformed before statistical analyses into square root and angular scale, respectively. A separate analysis of variance for the parental genotypes and their F_1, s for each character was done to detect the significance of the observed differences and calculate the least significant difference. Mean values of BC_4 progenies, their averages and their least significant differences were also computed as outlined by Sokal and Rohlf (1995).

Multivariate technique was used to evaluate leaf-shape parameters contributing to the variation and eventually towards polymorphism, and to assess the genetic relationships, similarities and dissimilarities, among all studied entries of each cross. For this purpose, principal components, PC, analysis was calculated from a matrix based on correlations between the contributed characters for all genotypes of each cross. The principal components were expressed as eigen values, latent roots, and manifested in eigen vectors for all studied characters in each PC axis. (Hair *et al.*, 1987). The PC analysis was also allowed for displaying the component scores of genotypes to be plotted simultaneously in a "joint plot " diagram. Since, each component score is a linear combination of the contributed characters and maximal amount of variation can be shown on the first and second PC axes (Johnson and Wichern, 1988). All these computations were performed using SPSS computer procedure (1995).

RESULTS AND DISCUSSION

Mean values of leaf shape characters of the studied cotton genotypes are presented in Tables 1 and 2. It is clear that "nectariless-Okra leaf " parent exhibited lower values of middle lobe length , leaf width and lobbing depth as compared with those of "Giza 83" which had higher values . The same trend was detected only for leaf width and lobbing depth compared with "Giza 85", which had similar lobe length as "Nectariless-Okra leaf" parent. These results were reflected in higher degree of lobbing and more leaf shape index values for "Nectariless-Okra leaf "parent than the other two Giza parents. However, most leaf shape characters of "Giza 83" were higher than those of "Giza 85". Interestingly, leaf shape index reflected a case of sharp oval-shaped leaf for "Nectariless-Okra leaf" parent comparing with the slight oval to round-shaped leaf of both Giza parents. But, F1 plants, of both crosses, showed some sort of intermediate scores. While, most BC_4 progenies in both crosses exhibited various scores of leaf shape measurements, some progenies were similar to their Giza parents and the others were near to "Nectariless-Okra leaf" parent.

Multivariate technique using principal components analysis, PCA, was performed to extract important components of variation employing eigen values. PCA was conducted on eight leaf shape characters related to insect resistance in the two cotton crosses and their BC4 progenies. In the analysis with eight variables, eight PC axes existed and only those exhibited high multivariate variances were considered. Thus, the first five PC axes were accounted for more than 97% of the total variation of all studied characters. The joint values and their contribution toward the total variation associated with the first five PC axes as well as their eigen vectors of each character for both crosses are given in Tables 3 and 4. PCA showed that the first PC axes accounted for about 37% and 43% of the multivariate variation among genotypes, showing the highest eigen values for "Giza 85 x Nectariless-Okra leaf " and "Giza 83 x Nectariless-Okra leaf " progenies , respectively. While, the first four PC axes accounted for more than 90% of the total variation in both crosses, but the fifth PC axis contributed with about 3-6 %. Likewise, the second PC axis appeared to contribute with equal variations among progenies of both crosses .In this regard, You *et.al.* (1998); Abdel-Sayyed *et.al.* (2000) and El-Mansy (2000) found that the accumulative contribution percentage for the first three PC axes of variation reached to about 85%, which agreed with our findings.

The relative magnitude of the eigen coefficient of each character, in relation to the first five PC axes from the components analysis, provided an interpretation for each component axis. Each character proved to be an important source in, at least, one PC axis. However, because each of PC axes was given equal weight in the multivariate analysis, some characters might possess greater importance in determining plant phenotypes than others (Hair *et al.*, 1987). The PCA showed that leaf width and leaf area were primary sources of variation having the largest coefficient in the first PC axis among progenies of both crosses. Depth and degree of lobbing appeared to have the second largest coefficient among the cross "Giza85 x Nectatiless-Okra " and showed the largest coefficient in the second PC axis among the cross "Giza x Nectariless-Okra". While, leaf shape index seemed to possess large coefficient also in the first PC axis among progenies of both crosses. Moreover, leaf thickness and middle lobe length exhibited the largest coefficient in the second and third PC axes among progenies of Giza 85 and Giza 83, respectively. But, leaf dry weight showed the largest coefficient in the third PC axis.

It is interest to note that characters having high coefficients on the same PC axis appeared to be correlated, which agreed with the findings of the Fiber Quality Research Unit (1988). Cai *et al* (1996) showed that the primary characters controlling earliness in cotton were biological earliness factors in the second PC axis. Likewise, You *et al* (1998), Abdel-Sayyed *et al* (2000) and El-Mansy (2000) reported that the first PC, among F_1 cotton crosses, was yield factors while, the second and third PCs comprised fiber properties and boll characters.

Furthermore, each genotype could be plotted at the component score on each PC axis, since each component score is a linear combination of the characters considering as an index. The two dimensional distance between genotypes could reflect a summary of differences based on all characters measured to the extent that the first two PC axes are effective in capturing the combined variance (Hair *et al*, 1987). Consequently, the first two PC axes were used to represent the fifteen genotypes of each studied cross; parents, F1 and BC_4 progenies. Figure 1 showed such representations for leaf shape parameters.

It is clear that the second PC axis ,PC_2, separated the Nectariless-Okra leaf genotype ,P_2, from both Giza 83 and Giza 85 as well as their corresponding F_1,s . The arrangement of F_1,s was corresponded to their Giza parents rather than to Nectariless-Okra one. However, most of BC_4 progenies; No.8, 9,10,11,12,13,14,and 15; were more close to their common parent Nectariless-Okra. Such a conclusion might assure the role of selection for choosing Nectariless-Okra characteristics in backcross generations. In this respect, Abdel-Sayyed *et al* (2000) and El-Mansy (2000) found that PC_2 separated the " naked seed-creamy lint" offtype and its F_1 progenies from Giza 45 and Giza 85 and their F_1 progenies and added that the arrangement of genotypes corresponded to their common parents.

By viewing these results, one could obtain a visual non-numeric grasp of the amount of genetic polymorphism existing among cotton material under consideration. Since, such analysis appeared to be appropriate for forming associations among genotypes, and would be useful, over time, in detecting any movement in the genetic basis of such cotton materials.

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Table : 1 Performance of leaf shape parameters in plants of the studied " Giza 83 X Nectariless –Okra leaf " at 70 days old .

Populations	Lobe length	Leaf width	Depth of lobe	Degree of lobbing	Shape index	Leaf area	Leaf thickness
P1	13.27	7.852	4.90	2.79	1.687	10.214	0.568
P2	11.90	4.492	1.93	6.22	2.623	7.348	0.712
F1	12.33	5.645	2.03	6.16	2.268	8.203	0.568
LSD	0.53	0.442	0.50	0.78	0.215	0.282	0.086
BC4 Progenies							
1	13.00	3.31	2.9	4.48	3.930	6.557	0.535
2	11.30	2.92	3.9	2.90	3.869	5.745	0.515
3	11.10	2.61	4.6	2.41	4.249	5.385	0.517
4	14.80	3.92	2.5	5.92	3.777	7.616	0.638
5	15.20	3.22	2.5	6.08	4.715	7.000	0.469
6	13.40	3.06	2.3	5.83	4.380	6.403	0.659
7	12.70	3.15	5.6	2.27	4.032	6.325	0.650
8	12.80	2.42	1.7	7.53	5.285	5.568	0.513
9	10.80	2.31	2.5	4.32	4.666	5.000	0.520
10	13.10	3.21	2.5	5.24	4.086	6.481	0.619
11	13.30	3.23	2.7	4.93	4.114	6.557	0.628
12	12.20	2.54	5.2	2.35	4.801	5.568	0.677
Mean	12.81	2.99	3.24	4.52	4.325	6.184	0.578
LSD	0.86	0.29	0.80	1.09	0.289	0.474	0.048

Table : 2 Performance of leaf shape parameters in plants of the cross" Giza 85 x Nectariless –Okra leaf "and its BC4 progenies at 70 days old .

Populations	Lobe length	Leaf width	Depth of lobe	Degree of lobbing	Shape index	Leaf area	Leaf thickness
P1	11.50	8.319	4.33	2.81	1.373	9.815	0.629
P2	11.90	4.492	1.93	6.22	2.623	7.348	0.712
F1	10.50	7.524	3.43	3.35	1.452	8.717	0.497
LSD at 5%	0.53	0.442	0.50	0.78	0.215	0.282	0.086
BC4 Progenies							
1	10.6	3.87	4.3	2.47	2.740	6.403	0.436
2	12.0	3.08	4.4	2.73	3.892	6.083	0.568
3	10.3	1.84	1.3	7.92	5.584	4.359	0.632
4	11.5	2.52	3.5	3.29	4.560	5.385	0.621
5	9.7	3.20	1.6	6.06	3.035	5.568	0.710
6	11.0	2.55	1.7	6.47	4.321	5.292	0.571
7	15.6	1.86	2.7	5.78	8.392	5.385	0.414
8	11.2	4.02	1.5	7.47	2.788	6.708	0.556
9	10.1	1.88	2.0	5.05	5.369	4.359	0.526
10	10.2	2.55	1.8	5.67	4.002	5.099	0.538
11	9.7	3.40	2.4	4.04	2.851	5.745	0.697
12	11.1	2.61	1.8	6.17	4.249	5.385	0.690
Mean	11.08	2.78	2.42	5.26	4.315	5.481	0.580
LSD at 5%	1.01	0.47	0.69	1.13	1.018	0.451	0.064

Table: 3 Principal components analysis of leaf shape characters associated with the cross "Giza83 X Nectariless-Okra" and its BC4 progenies showing eigen values * and eigen vectors of studied characters in the first five PC axes.

Parameters	PC axes				
	1	2	3	4	5
Eigen values	2.990	2.335	1.452	0.747	0.254
PC% of variation	37.374	29.180	18.155	9.341	3.178
Cumulative proportion of variation	37.374	66.555	84.710	94.051	97.229
Characters	Eigen Vectors				
Middle lobe length cm.	-0.379	-0.582	0.697	0.105	0.129
Leaf width cm.	-0.860	0.036	0.435	-0.170	-0.196
Depth of lobbing cm.	-0.166	0.908	-0.072	0.355	-0.014
Degree of lobbing cm.	0.032	-0.961	0.068	-0.201	0.110
Leaf shape index	0.794	-0.387	-0.074	0.226	-0.399
Leaf area cm2	-0.899	-0.128	0.395	0.017	-0.128
Leaf thickness mm.	-0.504	-0.016	-0.807	-0.107	-0.020
Leaf dry weight %	0.621	0.282	0.655	-0.056	0.104

* Latent roots

Table: 4 Principal components analysis of leaf shape characters associated with the cross "Giza85 X Nectariless-Okra" and its BC4 progenies showing eigen values * and eigen vectors of studied characters in the first five PC axes.

Parameters	PC axes				
	1	2	3	4	5
Eigen values	3.463	2.286	1.088	0.658	0.342
PC% of variation	43.288	28.573	13.600	8.230	4.281
Cumulative proportion of variation	43.288	71.861	85.461	93.691	97.972
Characters	**Eigen Vectors**				
Middle lobe length cm.	0.082	0.807	0.133	0.559	0.372
Leaf width cm.	-0.916	-0.053	0.302	0.057	0.121
Depth of lobbing cm.	-0.796	0.400	-0.419	0.068	-0.198
Degree of lobbing cm.	0.795	-0.227	0.499	0.085	0.085
Leaf shape index	0.757	0.573	-0.176	0.165	0.082
Leaf area cm^2	-0.882	0.006	0.374	0.170	-0.054
Leaf thickness mm.	0.036	-0.819	0.136	0.412	-0.305
Leaf dry weight %	0.009	-0.608	-0.654	0.324	0.037

* Latent roots

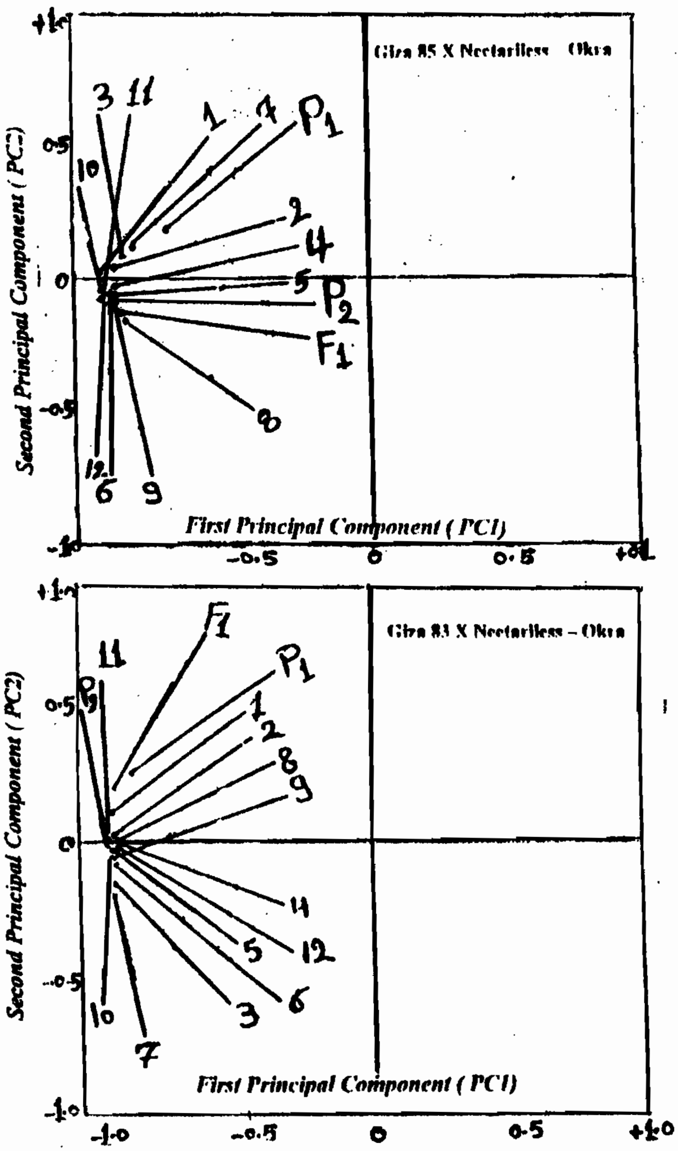

Figure 1 : Plot of first and second principal component axes for representation genotypes derived from the two studied crosses based on leaf shape characters.
(No 1-12 BC 4 progenies)

تعدد الأشكال الوراثية لصفات المقاومة للحشرات في بعض طرز القطن الوراثية : صفات شكل الورقة

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يهدف البحث إلى دراسة تعدد الأشكال الوراثية المورفولوجية لبعض صفات المقاومة للحشرات ، صفات شكل الورقة ، باستخدام تحليل المكونات الأساسية بين طرز القطن ، لهذا الغرض تم استخدام صنفي القطن جيزة ٨٣ ، جيزة ٨٥ و السلالة الأمريكية ـ Nectariless " Okra" و كذلك هجن الجيل الأول الناتجة من تهجين الأصناف المصرية كأمهات مع السلالة الأمريكية بالإضافة إلى نسل الجيل الرجعي الرابع لهذه الهجن (BC4) .

أظهرت السلالة الأمريكية اختلافا معنويا في قياسات شكل الورقة مقارنة بالأصناف المصرية ، و أظهرت بيانات الجيل الأول قياسات وسطية . أما معظم نسل الجيل الرجعي الرابع للهجينين فأظهر قياسات متباينة ، البعض كان مشابها للآباء المصرية و البعض الأخر كان قريبا من شكل الورقة للسلالة الأمريكية.

أظهر تحليل المكونات الأساسية أن عرض و مساحة الورقة هما المصدر الأول للتباين معطية أكبر معامل في المحور الأول للمكونات الأساسية لكلا الهجينين. أما المحور الثاني للمكونات الأساسية فقد فصل بين السلالة الأمريكية و الأصناف المصرية و كذلك أفراد الجيلين الأولين، و قد كان معظم أفراد الجيل الرجعي الرابع لكلا الهجينين قريبا من الأب المشترك الأمريكي مؤكدة دور الانتخاب في اختيار خصائص السلالة الأمريكية في أجيال الهجن الرجعية. و قد عكست هذه النتائج إدراك مرئي و غير رقمي لكمية تعدد الأشكال الوراثية الموجودة في طرز القطن المدروسة.