HETEROSIS AND GENE ACTION FOR PARTIAL DIALLEL CROSSES IN COTTON
I. COTTON INSECT RESISTANCE AND MULTIVARIATE ANALYSIS FOR TRAITS RELATED TO INSECT RESISTANCE

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Abstract

This investigation was carried out at Giza Experimental Station, Agricultural Research Center, Egypt in 2002, 2003 and 2004 growing seasons using partial diallel crosses system among eight parents to estimate heterosis, potence ratio, inbreeding depression, combining ability, gene action and heritability for infestation percentage.

Multivariate analysis was used to determine the intercorrelation between morphological traits and anatomical characters, with infestation percentage of bollworm to assess the importance of these traits. The results indicated that the damage was more in F_1s than parents, Positive and significant inbreeding depression in F_2 except for (G.90 x Okra leaf). G.C.A and S.C.A variances were highly significant in both generations with more importance for non additive gene action. The parents Nectariless, Okra leaf and G.90 were good combiners for decreasing infestation percentage. The broad sense heritability values were high in both generations, while narrow sense heritability values was moderate in F_1. Significant negative correlations were observed between infestation percent and mean petiole diameter, number of xylem rows of petioles, placenta thickness and central leaf lobe index , while significant positive correlations were found in cortex thickness / stem , bract index and plant height. The factor analysis revealed that the traits of central lobe index , placenta thickness, lobing index, number. of xylem of petiole and mean petiole diameter have inter-relationship with infestation percent of insect.

INTRODUCTION

Cotton has been a major source of the national income of Egypt. Recently the cotton cultivated area was drastically decreased due to reduction in income obtained from cotton cultivation. This reduction in income was attributed to the high cost of pest control during cotton growth season and the yield and quality losses caused by pink bollworm and other insects . EL-Zik and Thaxton (1989) reported that the resistance to insect was associated with several plant morphological traits such as okra leaf, frego bract nectariless, dense hair ,glabrus and red plant colour. Ali (2006) reported that reduction rate of number of pink bollworm ranged from 71.44% for (G.88 X Okra leaf) to 81.69 % for (G.90 X Hairy leaf).Darweesh (2006) reported that

F_2 and BC2 Plants of cross (G.90X Mar GN-8) gave the highest reduction percentage of pink bollworm infestation percent. Meanwhile the reduction percentages for F_2, BC2, F_1 and BC1 in crosses were higher than for Egyptian cotton variety (G.90). Max (2004) found that multivariate techniques principle components revealed leaf area and leaf shape index were important components among the studied traits related to insect resistance in cotton , also the found second Pc axis separated two lines Nectariless - Okra leaf from both Giza 83 and Giza 85 parents and their F_1s.

The primary objective of this study is to determine the heterosis, gene action and heritability for infestation percentage as well as the inercorrelation between morphological traits and anatomical characters, with infestation percentage of bollworm to assess the importance of these traits in the resistance for pink bollworm.

MATERIALS AND METHODS.

The material of this investegation inclucled five Egyptian cotton cultivars of *G. barbadense*, L, namely G.91, G.90, G.70, G.88 and Suvin and Upland cotton lines insect resistant *G. hirsutum* L namely Okra leaf , Frego bract , and Nectariless. The crosses were made in 2002 at Giza Experimental Station using a partial diallel mating design including the eight parents. In 2003 F_1 plants were grown to produce selfed seed of F_2 progeny and crossing among the eight parents to produce more F_1 seeds. In 2004 season, the eight parents with the 12 F_1 and F_2 hybrids were grown in a randomized complete block design with three replications. The parents were treated as random effect. The rows were 4m. long and 60 cm. between rows, hills were spaced 20 cm within rows seedling stage plants were thinned to two plants / hill. Standard cultural methods were applied. The measurements were taken on ten guarded individual plants in each plot for the morphological characters, lobing index, bract index, central leaf lobe index (cm), size of leaf nectarines (The measurement were in mm and transformed to its Log.), number of locules / boll, plant height (cm.) at picking time and infestation percentage: the ratio between number of infested locules per plant / total number of locules per plant.

Anatomical traits including specimens for the anatomical study, were taken from stems, (the visible internode below shoot apex), median leaf (petiole and blade) of the main stem in addition to the boll. Samples were taken at the age of 79 days from the eight parents and the twelve F_1 hybrids, sections were measured by micrometer lens, to detect histological measurements and counts of the studied genotypes. Averages of three readings were calculated.

Statistical and genetic analyses

1- The analysis of variance was calculated according to F- tests by Cochran and Cox (1957).

2- Estimation of general and specific combining ability effects for partial diallel by Chaudhary *et. al.* (1977).

3- Heterosis percentages were calculated relative to mid- parents (M.P.) and better parents (B.P.):

H. (M.P.) = F1 –M.P. /M.P. x 100.

H. (B.P.) = F1 – B.P / B.P. x 100.

4- Inbreeding depression (I.D %.):

$$I.D. = \frac{\overline{F}_1 - \overline{F}2}{\overline{F}_1} x 100$$

5– Potence ratio (p) Calculated from the formula given by Smith (1952) to determine the degree of dominance. $\mathbf{P} = \frac{\bar{F}_1 - \overline{M}.P}{\frac{1}{2}(\bar{P}_2 - \bar{P}_1)}$

The significance of heterosis and inbreeding depression were T. tested by:

L.S.D, mid-parents heterosis = $t_x \times \sqrt{\frac{3MSe}{2r}}$

L.S.D, better-parent and inbreeding depression = $t_x \times \sqrt{\frac{2MSe}{r}}$

6- Heritability estimate in broad sense (h^2 b_s %) and narrow sense (h^2 b_n %) were calculated by Verhalen and Murray (1969), it was measured for all the studied characters in F_1 and F_2 generations by the formulae:

F_1: h^2 b_s % = [(½ A +D)/ (½ A +½ D + E)] x100.

h^2 b_n% = [½ A / (½ A +½ D + E)] x100.

F_2: h^2 b_s % = [(¼ A +½D)/ (¼ A +½ D + E)] x100.

h^2 b_n% = [¼ A / (¼ A +½ D + E)] x100.

Where: A = Additive gene effect. D = Dominance gene effects, E = Environmental effect.

7. Multivariate analysis

The factor analysis methods, discussed by Cattle (1965) consisted of the reduction of large numbers of correlated variables sed smaller numbers of cluster variables called (Factors).

RESULTS AND DISCUSSION

Infestation percentage and multivariate analysis

a) Infestation percentage

1. Mean squares and combining ability

The analysis of variance of the eight parents and their F_1 and F_2 partial diallel hybrids for infestation percentage is presented in Table (1). Data showed that mean squares of genotypes of parents, F_1 and F_2 were highly significant indicating that the damage was different due to genotype variability and then , the genetic material was valid to proceed for further analysis. Also, the results in Table (1) showed highly significant interactions to mean squares of parents' vs crosses, and F_1vs F_2 indicating that the average heterosis and inbreeding depression over all crosses, were significant for this trait. The variance of F_1 and F_2 hybrids were partioned into main effects, general combining ability (G.C.A) which equal half the additive genetic variance and specific combining ability (S.C.A) which equal the dominance gene effects. Data in Table (2) revealed that both G.C.A and S.C.A variances were significant for this trait in both generations. These results suggested the presence of both additive and non additive in F_1 with more magnitude of additive gene effect. Meanwhile the additive in F_2 is equivalent to zero value due to the negative values. These results were in partially agreement with that obtained by Seif El-Nasar (1987). The data in Table (2) also revealed that narrow sense heritability values were moderate in F_1 generation , while the value of heritability in F_2 was neglectful value.

2. Performance of parents and general combing ability effects

Table (3) showed mean Performance and G.C.A effects for eight parents. The mean value of parents showed differences with range of 7.71 for Nectariless strain to 23.26 for Giza 70. The results showed that Nectariless and Okra leaf exhibited little damage for bollworm. Comparable results were obtained by Abd El-Bary *et. al.* (1980), Benedict *et. al.* (1981), Meredith *et. al.* (1996) and Ali (2006).

The data in Table (3) suggested that Nectariless, G.91 and G.90 were good combiners for reducing the infestation percentage in F_1 generation, while Okra leaf was good combiner for decreasing the infestation percentage in F_2.

3. The Performance of F_1s generation, heterosis and potence ratio

Table (3) showed that the two hybrids of (G.90 x Okra leaf) and (G.70 x Nectariless) exhibited lower values of infestation percentage. While (G.70 x Nectariless) exhibited the largest negative heterotic effect (desirable effect) and (G.90

x Okra leaf) exhibited non significant heterotic effect. Both hybrids showed that potence ratio was less than unity indicating partial dominance. These results suggested that the above two hybrids were better for infestation percentages. Most of other crosses exhibited significant and positive heterotic effect and the potence ratio were more than unity suggesting over dominance. The results indicated that damage were more in F_1s than in their parents.

4. The Performance of F_2 generation and inbreeding depression

Table (3) presents means of F_2 performance and inbreeding depression, the data showed that mean performance of F_2 were less than mean performance of F_1. The ranges of mean performance were 6.65 for (G.88 x Nectariless) to 15.57 for (G.90 x Frego bract).

The data showed that all hybrids exhibited positive and significant inbreeding depression effects except for (G.90 x Okra) .which indicate that the damage in F_2 was less than damage in F_1 and parents. These results confirm that this cross was better for low damage by bollworm.

b) Correlation between the infestation percentage and other morphological and anatomical traits

Simple correlation coefficients between infestation percentage and 18 variables including morphological and anatomical traits are shown in Table (4). The results clearly indicate that the mean petiole diameters, number of xylem row / bundle of petiole, placenta thickness and central leaf lobe index were significant and negatively correlated with infestation percentage with values of -0.524, -0.593, -0.615 and -0.531, respectively. Significant and positive association was found between infestation percentage and cortex thickness, bract index and plant height with values of 0.560, 0.435 and 0.510, respectively.

c) Principal components analysis

Multivariate technique using Principal Components Analysis, PCA was performed to extract important components of variation, resolving phenotypic measurements into fewer and easily visualized diameters that affect the character under study .PCA seemed to elucidate patterns of variation in morphological, anatomical and infestation percentage attributes to obtain the initial factors solution using eigen values, which measured the exploited variance associated with each variable factor (Hair *et. al.* 1987). Therefore, principle components analysis was conducted on eight characters related to insect resistance, earliness traits and ten anatomical traits. In this analysis nineteen variables axes existed and only those which are exhibited high multivariate variances were considered. Thus, the first four principal components axes accounted for more than 72.6% of total variance of all characters. The joint values and their contribution toward the total variation associated with the first four principal components axes as well as eigen vectors of each characters are given in Table (4). Principal components showed that the first principal components axis accounted for about 35% of the multivariate variation among genotypes. While the next three axes accounted for about 37% and were followed by three axes (fifth, sixth and seventh) which accounted for about 17% of the total variance. In this respect, Gutierrez *et. al.* (1988) reported that the first three principal components accounted for 54% of the total variability among twenty *G. hirsutum,* cultivars for 16 studied traits. Likewise, Brown (1991) studied PCA, of cotton cultivars based on 17 agronomic and fiber characters measurements and reported that the first three PCA accounted for no less than 62% of total variance of all characters which agreed with these finding. While You *et. al.* (1998) selected three Pc_5 and found that their accumulative contribution percentage of variance accounted for 85%. The relative magnitude of the eigen coefficient of each character related to the first four axes from the components analysis which might provide an interpretation for each component axis. Though no clear guide lines existed to determine the significance coefficients > 0.3 treat as having a large enough effect to be considered important (Hair *et. al.* 1987). The sign of the eigen coefficient is being irrelevant and in fact arbitrary, though negatively correlated characters will be generally of opposite signs on given axes. Each character was an important source of variation in at least one principal component axis, because each of PC axes, was given equal weight have greater importance in determining plant phenotypes than others (Hair *et. al.* 1987) .

Table (5) Showed that the first three axis were of equal importance and account for about 58% of the total variance, while the fourth axis was less important accounted for about 14.7%. The PCA axes showed that the traits central leaf lobe index, lobing index, placenta thickness, cortex thickness /stem, number of locules / boll and infestation percentage were the primary sources of variation having the largest coefficient in the first Pc axis. These results suggested that inter-correlation is implied among these traits with high coefficients for these traits on some axis (Brown 1991). However bract index, size of leaf nectaries and days to first flower appeared to have the second largest coefficient in the first Pc axis. Morewhile, the three characters: bract index, size of leaf nectaries and days to first flower as well as number of xylem row / bundle of leaf, number of locules, blade thickness and lint yield exhibited the largest coefficients in the second Pc axes. The third principal component accounted for about 19% of total variance of all traits, the larger coefficient are mean pith diameter, mean stem diameter, mean bundle diameter / stem, plant height and locules wall thickness. The forth principal component accounted 14.7%, for the number of xylem row of petiole, means petiole diameter, infestation percentage and plant height. These results suggested that an inter-correlation is implied between the infestation percentage and number of xylem row / petiole, mean petiole diameter and plant height. The factor analysis provided additional information, however by grouping the 19 variables into four main factors with the first three groups being of equal importance. The first axis indicated the importance of central leaf lobe index, lobing index and placenta thickness and the second axe indicated the importance of number of xylem row / bundle of leaf and bract index, while the third axe indicated the importance of mean pith diameter, mean stem diameter and cortex thickness/stem. The forth axe indicated that importance for the number of xylem row / bundle of petiole and mean petiole diameter. Mean stem diameter and mean pith diameter seemed to be the most important variable had a large communality value h^2 = 0.894, 0.877 respectively.

The results of multivariate were in harmony with the result of correlation coefficient between the infestation percentage and number of xylem rows / bundle of petiole , placenta thickness and central leaf index, cortex thickness, bract index and plant height.

It could be conculded that traits central lobe index , placenta thickness , lobing index, number of xylem rows and mean petiole diameter have interrelationshipe infestation percentage by insects.

Table 1. Mean squares, infestation percentage for parents, F_1 and F_2 generations of partial diallel hybrids in cotton.

S.O.V	d. f	Mean squares
Replications	2	14.631
Genotypes	31	116.95**
Parents	7	101.19**
F_1	11	68.61**
F_2	11	23.52**
P. vs. F_1 hybrids	1	548.59**
F1.vs.F_2 hybrids	1	1355.09**
Error	62	3.84

*, ** Significant at 0.05 and 0.01, respectively.

Table 2. Mean variances for general and specific combining ability, gene action and heritability for infestation percentage parents, F1 and F2 generations of partial diallel crosses in cotton.

S.O.V	d. f	Mean squares
G.C.A F_1	7	90.33**
S.C.A. F_1	4	30.59**
G.C.A. F_2	7	22.40**
S.C.A. F_2	4	25.48**
$\sigma^2G/\ \sigma^2S\ F_1$		0.90
$\sigma^2G/\sigma^2S\ F_2$		zero
Additive F_1		15.49
Dominance F_1		8.92
Additive F_2		-0.80
Dominance F_2		7.21
$h^2_{b.s}\ F_1$		92.87
$h^2_{n.s}\ F_1$		43.17
$h^2_{b.s}\ F_2$		73.80
$h^2_{n.s}\ F_2$		0.00

*, ** Significant at 0.05 and 0.01, respectively.

Table 3. Mean performance, general combining ability effects, heterosis relative to mid and better parent, potence ratio and inbreeding depression for infestation percentage in F1 and F2 generations of partial diallel hybrids in cotton.

Genotypes	Parents			F_1				F_2	
	Mean P %	GCA F_1	GCA F_2	Mean F_1 %	M.P	B.P	P.R	Mean F_2 %	I. D.
G.91 x G.88	22.50	-2.90*	1.35	23.46	34.67**	90.11**	1.19	14.56	37.94**
G.91 x Suvin	17.04	-9.16**	3.83**	19.94	-1.56	10.72	-0.14	9.20	50.25**
G.91 x Frego	23.26	-2.34	1.67	29.25	65.53**	127.80**	2.40	11.68	60.07**
G.90 x Suvin	12.34	4.16**	-0.61	20.20	15.26	18.54	5.52	14.97	25.89*
G.90 x Frego	18.01A	4.91**	-0.18	18.34	22.76	42.83**	1.62	15.57	28.52*
G.90 x Okra	12.84	7.70**	-0.98	13.03	-0.42	42.72*	-0.01	10.75	17.05
G.70 x Frego	9.13	1.84	-2.95*	25.71	42.44**	100.23**	1.47	10.56	58.93**
G.70 x Okra	7.71	-4.22**	-2.14	22.85	41.09**	150.27**	0.94	12.09	47.09**
G.70 x Nect.				14.33	-31.11**	85.86**	-0.15	10.21	28.82*
G.88 x Okra				26.89	150.49**	194.52**	10.07	7.12	73.52**
G.88 x Nect.				21.44	39.77**	178.08**	4.93	6.65	68.98**
Suvin x Nect.				22.89	25.94**	196.89**	1.95	11.50	49.76**
Mean	15.35			21.53				11.24	
L.S.D $_{0.05}$	3.20	2.70	2.70	3.20	2.78	3.20		3.20	3.20
L.S.D$_{0.01}$	4.26	3.59	3.59	4.26	3.70	4.26		4.26	4.26

P1:G.91 P2 :G.90 P3:G.70 P4 :G.88 P5:Suvin P6: Frego bract P7: Okra leaf P8:Nectariless

Table 4. Total variance for morphological and anatomical traits and the correlation coefficients between morphological traits, lint yield, days to first flower, anatomical traits and infestation percentage.

Component	Initial Eigen values			Characters	Correlation coefficient
	Total	% of variance	Cumulative %		
1	6.760	35.575	35.575	Blade thickness	0.043
2	3.331	17.532	53.111	No. of xylem row/leaf	0.015
3	1.979	10.417	63.528	Mean petiole diameter	- 0.524*
4	1.721	9.059	72.587	No. of xylem row bundle of/petiole	- 0.593*
5	1.295	6.813	79.400	Mean main stem diameter	0.369
6	1.026	5.398	84.799	Cortex thickness/stem	0.560*
7	0.876	4.610	89.409	Average area of bundle stem	0.275
8	0.490	2.578	91.987	Mean pith diameter	0.318
9	0.470	2.474	94.462	Locules wall thickness	0.222
10	0.348	1.833	96.294	Placenta thickness	-0.615*
11	0.193	1.017	97.311	Days to first flower	0.238
12	0.153	0.806	98.117	Lint yield	-0.220
13	0.139	0.733	98.850	Lobing index	-0.342
14	7.980	0.420	99.270	Bract index	0.435*
15	6.742	0.355	99.625	Size of leaf nectaries	0.202
16	4.462	0.235	99.859	Central leaf lobe index	-0.531*
17	2.234	0.118	99.977	No. of locules/boll	-0.303
18	4.276	2.250	100.00	Plant height	0.510*
19	8.420	4.431	100.00	Infestation percentage	1.00

Table 5 . Principle factor and communalities of each morphological traits0 , lint yield, days to first flower and anatomical traits in partial diallel hybrids.

Factor	Variable	Communality	PC Axes			
			Pc1	Pc2	Pc3	Pc4
1	Central leaf lobe index	0.844	0.894	-0.175	-0.105	0.057
	Lobing index	0.848	0.840	-0.330	0.093	-0.156
	Placenta thickness	0.732	0.722	0.019	-0.349	0.298
	Cortex thickness/stem**	0.727	-0.606	0.308	0.443	0.262
	No. of locules/boll*	0.806	0.524	-0.705	-0.123	0.142
	Infestation percentage****	0.758	-0.554	-0.023	0.165	-0.651
2	No. of xylem row/leaf	0.623	0.028	0.758	0.177	-0.130
	Blade thickness	0.533	0.171	0.704	0.083	0.011
	Bract index*****	0.786	-0.354	0.673	0.158	-0.427
	Size of leaf nectaries	0.665	-0.403	0.661	-0.058	-0.251
	Days to first flower	0.617	-0.418	0.660	-0.018	0.079
	Lint yield	0.562	0.299	-0.645	0.207	-0.115
3	Mean pith diameter	0.877	-0.054	0.021	0.920	-0.168
	Mean main stem diameters	0.894	-0.244	0.155	0.896	-0.083
	Average area of stem bundle	0.693	0.036	-0.057	0.822	-0.116
	Plant height***	0.783	-0.281	-0.089	0.660	-0.510
	Locules wall thickness****	0.539	0.042	-0.200	-0.560	0.428
4	No. of xylem row bundle/ petiole	0.857	0.082	-0.217	-0.198	0.874
	Mean petiole diameter	0.648	-0.035	-0.101	-0.062	0.796
Variance		13.79	3.71	3.68	3.61	2.80
Var %		0.726	0.195	0.194	0.190	0.147

* Important at both first and second axes.
** Important at both first and third axes.
*** Important at both third and forth axes.
**** Important at both first and forth axes.
***** Important at both second and forth axes.

Table 6. Mean performance of eight parents, F_1' s and F_2' s for morphological traits in partial diallel hybrids of cotton.

Genotypes	Lobing index		Bract index		Size of leaf nectaries (mm)		Central leaf lobe index		No. of locules/boll		Plant height (cm)	
(P_1) G.91	75.61		68.77		1.18		1.73		3.00		175.67	
(P_2) G.90	75.50		76.92		2.41		1.83		3.00		160.33	
(P_3) G.70	76.86		70.14		2.12		1.85		3.03		171.67	
(P_4) G.88	76.49		71.49		1.65		1.74		3.0		176.67	
(P_5) Suvin	78.83		63.47		1.62		1.79		3.4		148.33	
(P_6) Frego	67.91		39.31		1.61		1.35		4.57		111.67	
(P_7) Okra	94.02		56.79		1.48		4.36		4.70		121.50	
(P_8) Nect	93.63		44.49		1.00		3.82		4.70		114.67	
Mean	79.86		61.42		1.71		2.31		3.68		147.56	
Crosses	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
$P_1 \times P_4$	76.81	77.35	65.26	69.60	1.75	1.78	1.82	1.76	3.1	3.10	163.33	174.33
$P_1 \times P_5$	74.97	76.71	74.61	73.30	2.11	1.68	1.82	1.73	3.1	3.03	108.60	175.20
$P_1 \times P_6$	73.81	73.55	63.13	65.55	1.51	1.63	1.56	1.48	3.97	4.17	149.33	180.50
$P_2 \times P_5$	75.59	76.97	68.70	67.26	2.04	1.84	1.89	1.87	3.07	3.17	123.77	164.10
$P_2 \times P_6$	73.07	75.45	59.68	64.95	2.15	2.32	1.68	1.71	3.90	3.50	174.70	156.67
$P_2 \times P_7$	81.17	81.94	51.07	63.27	1.64	1.59	2.13	2.37	3.73	3.70	147.00	155.67
$P_3 \times P_6$	75.88	74.62	66.26	63.89	1.47	1.57	1.66	1.48	4.00	4.13	174.00	166.0
$P_3 \times P_7$	86.92	86.85	56.92	65.07	1.53	1.62	2.53	2.86	4.10	3.67	178.50	166.87
$P_3 \times P_8$	86.00	78.42	60.03	62.39	1.54	1.50	2.34	1.90	4.17	3.77	165.17	171.00
$P_4 \times P_7$	84.04	85.67	59.69	62.89	1.60	1.50	2.21	2.33	4.03	4.00	177.00	158.20
$P_4 \times P_8$	84.98	73.85	61.73	65.03	1.47	1.55	2.28	1.80	4.00	3.77	166.50	135.50
$P_5 \times P_8$	85.44	76.60	60.72	57.90	1.50	1.57	2.22	1.89	4.17	4.03	168.00	135.67
Mean	79.89	78.17	62.32	65.09	1.69	1.68	2.01	1.93	3.78	3.67	157.99	161.64
$L.S.D_{0.05}$	3.46		3.44		0.20		0.36		0.28		11.20	
$L.S.D_{0.01}$	4.60		5.58		0.32		0.48		0.37		14.90	

Table 7 . Counts and measurements (μ) of main stem, petioles, leaves and cotton boll for eight parents and F_1 hybrids of partial diallel crosses at 79 day - old.

Genotypes	Mean main stem diameter (μ)	Cortex thickness /stem (μ)	Mean stem bundle diameter (μ)	Mean pith diameter (μ)	Mean petiole diameter (μ)	No. of xylem bundle of petiole	Blade thickness (μ)	No. of xylem row /leaf	Locules wall thickness (μ)	Placenta thickness (μ)
G.91	1216.25	192.5	1531.25	1198.75	2283.75	9	175.0	35	175.0	252.0
G.90	10645.0	192.5	1260.0	1076.25	1522.90	9	175.0	27	157.5	700.0
G.70	1750.00	175.0	1382.5	1102.5	1636.25	9	140.0	21	262.5	700.0
G.88	1837.50	192.5	1356.25	1111.25	2817.50	11	122.5	27	175.5	612.0
Suvin	1802.50	192.5	1513.75	1137.5	1855.00	9	157.5	21	192.5	875.0
Frego bract	1452.50	157.5	1163.75	910.0	2607.50	9	140.0	21	210.0	700.0
Okra leaf	1540.00	157.5	1295.0	1032.5	2485.00	8	140.0	27	262.5	1050.0
Nectariless	1540.00	140.0	1382.5	953.75	2423.75	7	140.0	17	192.5	1050.0
G.91 xG.88	1837.50	192.5	1426.25	1076.25	2100.00	8	140.0	25	280.0	525.0
G.91xSuvin	1715.0	175.0	1382.5	1023.75	2143.75	8	140.0	25	262.5	787.5
G.91xFrego	1671.25	175.0	1487.5	1128.75	1723.75	9	140.0	27	210.0	787.5
G.90xSuvin	1645.0	192.5	1251.25	988.75	2012.50	9	140.0	18	175.0	787.5
G.90xFrego	1872.5	192.5	1505.0	1128.75	1907.50	8	140.0	25	175.0	787.5
G.90xOkra	1802.5	140.0	1373.75	1146.25	1750.00	9	157.5	19	175.0	875.0
G.70xFrego	1802.5	192.5	1426.25	1216.25	2056.25	8	140.0	23	175.0	612.5
G.70xOkra	1968.75	170.5	1540.0	1216.25	1863.75	8	140.0	24	210.0	647.5
G.70xNect.	1881.25	175.5	1645.0	1312.5	1846.25	9	122.5	24	175.0	700.0
G.88xOkra	1968.75	192.5	1540.0	1181.25	1933.75	8	170.0	18	210.0	612.5
G.88xNect.	1505.0	157.5	1277.5	971.25	1697.50	12	160.0	24	297.5	700.0
suvin x Nect.	1618.75	175.0	1303.75	1023.75	1723.75	9	122.5	18	245.0	647.5

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قوة الهجين والفعل الجينى لبعض الهجن فى القطن باستخدام الهجن التبادلية الجزئية
١ - لصفة المقاومة للحشرات وتحليل العامل المتعدد لبعض الصفات المرتبطة بالمقاومة

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تهدف هذة الدراسة لتقدير قوة الهجين والفعل الجينى لنسبة الاصابة وقد أستخدم تحليل العامل المتعدد لتحديد العلاقة المشاركة بين بعض الصفات المورفولوجية والتشريحية للساق ، الورقة، عنق الورقة، واللوزة مع نسبة الاصابة بديدان اللوز وقد أستخدم فى هذة الدراسة خمسة أصناف من القطن المصرى بالآضافة الى ثلاث سلالات من اقطان الآبلند الامريكية المقاومة للحشرات وقد تم التهجين بين الاباء بطريقة الهجن التبادلية الجزئية واجريت هذة الدراسة فى محطة البحوث الزراعية بالجيزة خلال ثلاثة مواسم 2002 ،2003. 2004 ويمكن تلخيص النتائج كما يلى:

١- اظهر تحليل التباين لنسبة الإصابة بديدان اللوز وجود فروق معنوية بين جميع التراكيب الوراثية وبين الاباء وايضا بين الا باء والهجن وبين الجيل الاول والثاني.
٢- كانت هناك قوة هجين معنوية موجبة بالنسبة لمتوسط الابوين لنسبة الاصابة في معظم الهجن و كانت السيادة الفائقة هي التي تحكم هذه الصفة وكانت قيم الانخفاض الراجع للتربية سالبة وذلك يوضح ان الاصابة في الجيل الاول كانت أعلى مقارنة بالآباء، وكانت موجبة معنوية في كل الهجن ماعدا الهجين (جـ ٩٠ × Okra).
٣- كان كلا من التباين الراجع للقدرة العامة والخاصة على الائتلاف لنسبة الاصابة عالى المعنوية مما يوضح اهمية التاثير غير المضيف للجينات لتحسين نسبة انخفاض الاصابة بالحشرات.
٤- وجد ان افضل الاباء قدرة علي الائتلاف لخفض نسبة الاصابة لديدان اللوز السلالتين التابعتين للقطن الأمريكي Nectariless ، Okra leaf وكذلك جيزة ٩٠ ، وكانت الكفاءة الوراثية بمعناها الواسع لنسبة الإصابة عالية في كلا الجيلين بينما كانت في المعنى الضيق متوسطة في الجيل الاول.
٥- اظهر معامل الارتباط البسيط بين نسبة الإصابة لديدان اللوز والصفات المورفولوجية والتشريحية وجود ارتباط معنوي سالب ومرغوب بين نسبة الاصابة وكل من الصفات الآتية: متوسط قطر العنق، عدد صفوف الخشب في حزمة العنق، سمك المشيمة في اللوزة، معامل الفص الاوسط للورقة، كما وجد أيضا ارتباط معنوي موجب بين سمك القشرة للساق، معامل القنابة ،ارتفاع النبات مع نسبة الاصابة لديدان اللوز.

٦- أوضح تحليل العامل المتعدد (Multivariate) أو تحليل المكونات الأساسية لثمانى صفات لها علاقة بالمقاومة لديدان اللوز مع عشر صفات تشريحية إن الصفات تحت الدراسة تجمعت في أربعة محاور وهي تمثل ٧٢,٦% من التباين الكلي وذلك في كل الصفات تحت الدراسة .

- أظهرت النتائج إن ثلاثة محاور للمكونات الأساسية لها أهمية متساوية وتمثل نسبة ٥٨% من التباين الكلى وان المحور الرابع هو اقل أهمية ويمثل نسبة ١٤,٧ % من التباين الكلي.
- أظهر تحليل العامل المتعدد زيادة قيمة معامل المشاركة لصفات متوسط قطر الساق، ومتوسط قطر النخاع مما يدل على أهميتها كمكون للتباين.

نستخلص من نتائج تحليل العامل المتعدد انه توجد علاقة بين المقاومة لديدان اللوز وبين الصفات التشريحية التي درست سواء الخاصة بالساق ،الورقة ،العنق، اللوزة وارتباط ذلك بالصفات المورفولوجية للورقة كصفات معامل الفص الأوسط للورقة ،معامل التفصيص، سمك المشيمة في اللوزة ،عدد صفوف الخشب / الورقة، معامل القنابة، متوسط قطر الساق، متوسط قطر النخاع، سمك القشرة للساق، عدد صفوف الخشب في حزمة العنق، متوسط قطر العنق.

وبناء على ذلك فأن المقاومة لديدان اللوز والمرتبطة بالصفات المورفولوجية تعتمد على الصفات التشريحية لنبات القطن كسمك المشيمة في اللوزة وعدد صفوف الخشب في حزمة العنق ومتوسط قطر عنق الورقة.