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DIALLEL ANALYSIS OF COTTON HYBRIDS (G. BARBADENSE, L) II – GENETIC BEHAVIOR OF FIBER TO SEED ATTACHMENT FORCE, FUZZ INDEX AND FIBER QUALITY INDEX

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Abstract

Hayman's diallel cross analysis was employed to investigate the nature of genetic system controlling fiber to seed attachment force, fuzz index and fiber quality index characters in Egyptian cotton. Nine parent and their half diallel crosses were grown in randomized complete block design with two replication

Heterosis was measured as departure of the F_1 from the average mid parent value. The heterosis effects were small for fiber – to seed attachment force and fuzz index. While fiber quality index exhibited significant effects. The epistasis of non-allelic interaction was absence for all characters.

The information were obtained with regard to D and H_1 suggested that in all traits the additive part of the genetic variance was more important than dominance. Concerning gene distribution, the two traits of fiber – to seed attachment force and fiber quality index exhibited equal distribution, while fuzz index exhibited unequal gene distribution. Dominance degree was partial for fuzz index and fiber quality index. While it was complete dominance for fiber to – seed attachment force.

Narrow sense heritabilities were 62. %, 90.45% and 62. % For fiber – to- seed attachment force, fuzz index and fiber quality index respectively.

The result obtained from distribution of parent along and / or around the regression line suggested that Giza 84, Giza 77 and Giza 85 were the best parents for breeding program for these traits.

INTRODUCTION

Selection and breeding procedures for genetic important of cotton is largely conditioned by the type and relative amount of genetic variance component in the population. The diallel cross analysis was used for partition the genetic variance into its components. These informations were made to improve cotton by selection of strains with low attachment strength and less fuzz index. Chapmen (1969), Fransen *et al.* (1984) and Al – Tantawy *et al.* (1991) found significant differences between varieties attachment strength. Wahba and Eweida (1990) reported that selection of strains with low attachment force would be associated with high ginning capacity, so the ginning coasts would be decrease. They reported that fiber with low attachment force related with decreasing fiber nips and improvement fiber quality Awaad (1989), Wahba and Ewida (1990) and Emam (1998) noted cotton fibers on fuzzy seed have greater attachment force than on naked seeds. Fuzzless seed of cotton is more important for agriculture mechanization and save the coast of delinting.

The present study was designed to estimate types of gene action, and heritability controlling the inheritance of attachment force, fuzz index and fiber quality index traits of cotton raised via. 9 parents cross diallel.

Parents also identification is of most importance for those parent, which carry the dominant alleles in breeding program of improvement for these traits.

MATERIALS AND METHODS

This study was carried out at Sakha Research station Agricultural Research Center. Egypt. Nine cotton genotypes namely (1) Giz83, (2) Giza 81, (3) Giza 80, (4) Giza 45, (5) Giza 85, (6) Giza 70, (7) Giza 84, (8) Giza 77 and (9) Giza 75 were used as experimental materials. The genotypes will be coded by 1 through 9 respectively Half diallel crosses were made among these nine genotypes at Agric. Alex Univ at 1993. The parental and $F_1{}^s$, hybrids where grown at April 7th 1994 in a randomized complete block design experiment with two replications in three rows plot. Each row was 4 m. long and 65 cm. Apart. Hills were spaced at 20 cm. Within row and seedlings were thinned to two plants / hill at May 5^{th} 1994.

The following observation and measurements were recorded on 10 individual guarded plants from middle row in each plot.

1. Attachment force: Fifty grams of seed cotton of each sample was taken for determine. Fiber – to – seed of attachment force by using L.D.M cottonseed attachment teser of shirely development, as discribed by Fransen *et al.* 1984.
2. Fuzz index, as the difference in weight of 100 seed before and after delinting with 50% sulfuric acid to 1-2 m
3. Fiber a quality index (F.Q.i) was obtained from the following equation:

$$F.Q.i = \frac{\text{Flat bundle strength at } \underline{1} \text{ inch x 2.5\% span. Length}}{\text{Hair weight in standard level (H.S)}}$$

Partitioning the genetic variance to its components was made as recommended by Hayman (1954), Jinks (1954) and Mather and Jinks (1971) for diallel crosses. The (Vr. Wr) graphs for each trait were developed according to jinks (1954) after computation of covariance – variance regressions. The genetic variance componets D, F, H_1, H_2, h^2, and E were as following :

D : The additive genetic variance.

F : The covariance of additive and dominance gene effects, which determined gene symmetry.

H_1 : Variation due to the dominance effect of genes.

H_2 : Dominance variance adjusted for symmetric positive and negative gene distribution among parents.

h^2 : Dominance variance over all heterozygous. Loci

E : The expected environmental variance.

To test the significance of these components standard error estimation Technique would be used as suggested by Hayman 1954.

Estimates of genetic ratios:

$(H_1/D)^{\frac{1}{2}}$ = The mean degree of dominance

H_2 / $4H_1$ = The proportion of genes with negative and positive effect in the parents and had a maximum value of 0.25

$$KD/KR = \frac{(4DH_1)^{\frac{1}{2}} + F}{(4DH_1)^{\frac{1}{2}} - F}$$

The proportion of both dominant and recessive alleles in the parents.

K = h^2 / H_2 : on estimator of groups number of genes that are involved in the performance of the trait and exhibit dominance to certain degree.

$$\text{Heritability in narrow sens} = \frac{1/2\ D + 1/2\ H_1 - 1/2 H_2 - 1/2\ F}{1/2\ D + 1/2\ H_1 - 1/4\ H_2 - 1/2\ F + E}$$

The coefficient of correlation between the parental order of dominance i.e (W_r + V_r) and the parental average measurements (V_r) was also computed.

RESULTS AND DISCUSSION

The mean squares values were obtained from ordinary variance analysis for fiber attachment force, fuzz index and fiber quality index, it is clear that all genotypes differed significantly (Table 1). This result ascertains assumption for distinct genotypic background of the parents involved.

I. Heterosis:

Heterosis expressed as percent increase of hybrid average above the average of the parents was small and insignificant for attachment force and fuzz index. Fuzz index heterosis was not in harmony with those obtained by El- Anani and Eatedal (1986). They reported that mid- parent heterosis was significant for fuzz index. The heterosis of fiber quality index was positive and significant. Individual heterosis effects were calculated for each hybrid. The number of hybrids that showed significant heterosis at level 0.05% are presented in Table 2. Regarding atrachment force, the data showed significant superiority of six F_1 over mid parent, which ranged between (31.17% - 61.87%) three exhibited negative and significant heterotic effect which ranged between (22.03%- 30.46%) however, for fuzz index $12F_1$ and $11F_1$ exhibited negative and positive heterotic effect which ranged between (8.90% - 24.79%), 7.90%- 19.8%), respectively. Concerning fiber quality index, hybrids had significant superiority over mid parents with a range of (8.17%- 27.71%) and one hybrid had negative heterotic affect. The combination of (p2xp3) and (p3xp5) were favorable combinations because these combinations scored less attachment force and less fuzz index and theire quality index traits did not differ from quality index their parents.

II. The diallel crosses

The validity to Hayman assumption:

Assumption and tests for their validity are as follows:

1. Diploid segregation: Gossypium barbadense L. is tetraploid (4n = 52) and segregates in diploid manner.
2. Homozygous parents: The parental lines were maintained by self-fertilization for three cycles and were assumed to be homozygous.

3. No reciprocal difference: The entries in the dialled table were replaced by their mean reciprocal for all characters prior to analysis.
4. No genotype- environmental interaction: insignificant variance for replicates showed insignificant genotype – environmental interaction.
5. No epistasis.
6. No multiple alleles and,
7. Uncorrelated gene distribution may be fulfilled through inspection,

Variance and covariance (V_r and W_r) interrelationships are shown in Table (1). Data indicate that t^2 which represents uniformity was insignificant for fiber attachment force, fuzz index and Fiber quality index result reveals that there is no evidence of non-allelic interactions variance components and the existence of allelic interactrion i.e., the validity of additive- dominance model.

II.A. Genetic parameters

Table (3) summarizes; the estimate of genetic variance component in addition to Hayman's genetic from diallel analysis for the studied traits. The data showed the significant of additive "D" and dominance effects (H_1 and or H_2). The results indicated that these additive effects were more important portions in the genetic variance of fuzz index and fiber quality index traits. While the importance of additive and dominance portion were equal for the attachment force trait.

H_1 greater than H_2 indicates that the positive and negative alleles at the loci for trait of fuzz index are not proportionally equal in the parent. While the results reveal insignificant differences between H_1 and H_2 for traits of attachment force and fiber quality index. This result indicates that positive and negative alleles at loci for these traits are equal proportionally in the parents. "F" was significant and negative for fuzz index trait suggests an excess of recessive genes in the parents for fuzz index. While this estimate was positive and significant indicating an excess of dominant genes in the parents for fiber quality index. Regarding the attachment force, this estimate was negative indicating that recessive gene were more frequent than dominant genes. h_2 values of fiber quality idnex trait was positive and significant indicating that dominance was unidirectional and the existence of many positive genes controlling this trait. While h_2 values were found to be not significant for attachment force and fuzz index indicating the absence of dominance effect over all loci in heterozygous phase. This result was in harmony with small heterosis. It may be due to absence the dominance effects in the parental materials.

Ultimately, (E) the environmental component of variance had small effect on the expression of genes controlling all studied traits.

II. B. Genetic ratios

The genetic ratios were computed using the genetic parameters to provide further information about the genetic system operation for each trait. The mean values of these estimates are presented in Table (3). Degrees of dominance of fuzz index and fiber quality index were less than unit indicating partial dominance. This result disagreed with those was obtained by El- Anani and Eatedal (1986). They found that degree of dominance for fuzz index was over dominance. The degree of dominance for attachment force was more than unity indicating complete dominance whose weight have been caused by close repulsion linkage.

$H_1/4H$ When this ratio equal 0.25; it means that the values of both positve alleles at loci exhibiting dominance are equal. The data in Table (3) show that this genetic ratio are equal 0.25 for attachment force and fiber quality index indicating that the values of both positive and negative alleles at loci exhibiting dominance are equal. This finding explain the causes of insignificant heterosis for attachment force and fiber quality index. While the ratio of H_2 / 4 H_1 for fuzz index was less than 0.25. This ratio indicates that the positive and negative genes exhibiting dominance were unequaled distributed among the parents. These results explain the causes of significant heterosis for fuzz index.

(KD/KR): estimates of this ratio indicate that the ratio of dominant to recessive alleles in the parent were less than unity for attachment force and fuzz index. This result suggested that the recessive genes were excess in the parents for attachmient force and fuzz index. While this genetic ratio for fiber quality index was more than unity indicating an excess of dominant genes. Thes results were in harmonies with the results discussed previously concerning in value of "F" component.

(K): The number of effective factors the controlling the traits and exhibit dominance to certain degree. The result showed that at least one effective factor for attachment force and fuzz indexes; while fiber quality index were governed by two genes. Zhang and Pan (1991) reported that one pair is responsible for the inhibition of fuzz fiber.

(r); The correlation coefficient between the parental means and parental order of dominance were negative and significant for attachment force and fiber quality index traits indicating that most dominant alleles act in positive direction and the most recessive ones act in the opposite direction for these traits. The negative sign in due to parents with preponderance of dominant alleles have lower array variance and covariance than recessive parents had. The data in Table (3) showed that "r" values were informative in determining the direction of dominance in F_1 for all traits with exception of fuzz index, which has low correlation value. Thus, it could be possible to identify those parents that possess high mean performance and low order of dominance for future breeding material. Thus, parents Giza 70, Giza 45and Giza 77 could be considered as good parents for the improvement fiber quality index traits. While for fuzz index; the good parents Giza 7 followed by Giza 84 and Giza 81.

The parent Giza 84, Giza 85 and Giza 85, were good parent for improvement to produce little attachment force strains

Heritability estimates were relatively high for all traits. These results suggested that the majority of total phenotypic variance was additive in nature. The heritabilities were 62%, 90.54%, 62% for attachment force, fuzz index andfiber quality index, respectively. The high Heritability for fuzz index was confirmed by Dawla *et al.* (1988). They reported that the estimate of heritability for fuzz percentage were relatively high.

It is apparent that the heterosis was due to the presence of dominance because "H_1" was highly significant and the regression coefficients were not significantly different from unity however they were significantly different from zero indicating the absence of non- allelic interaction.

The preponderance of additive genetic variance and low level of heterosis in attachment force and fuzz index are good indicators that the selection in early generation would be effective. This finding agreed with that was obtained by Dawla *et al.* (1988). They reported that the fuzz index would be responsive to direct selection intensity.

III. W_r/ V_r Graphic analysis

Figures 1, 2 and 3 represent the graphical analysis of regression of "W_r" (parent/ off spring covariance) on "V_r" (parental array variance) and their limiting parabola from "F_1" diallel analysis for the investigated characters. The figures illustrate that attachment force, fuzz index and fiber quality index have aslope "b" statistically equal to unit (b=1) which indicates the absence of non- allelic interaction. At the meantime the insignificant differences of "W_r/ V_r" (uniformity test) indicated the absence of non- allelic interaction.

With respect to V_r intercept relative to W_r axes; it was found that attachment force was controlled by complete dominance (Fig.1). While fuzz index and fiber quality index were controlled by partial dominance (Fig. 2 & 3). These results agreed with result were obtained from the value of $(H_1/D)^2$ Table (3). El- Anani and Eatedal (1986) for fuzz index did not agree with result obtained of the partial dominance. They reported that over dominance controlled fuzz index trait. Figures 1, 2 and 3 explain the genetic variability among the parents. Where the parents are distributed along and / or around the regression line as follow:

Figure 1 shows the parents of Giza 70, Giza 77 and Giza45 appeared to have most of the dominant genes for attachment force. On the other hand, Giza 83 and Giza 84 appeared to possess most of the recessive genes. While Giza 81, Giza 80 and Giza85 contain equal portions of dominant and recessive genes for this trait.

Figure 2 shows that Giza 70 appeared to contain most of the dominant genes for fuzz index. On the other hand Giza 84 and Giza77 appeared to contain most of the recessive genes. The parents of Giza 81, Giza83 and Giza80 appeared to contain (0.75- 0.50) of the dominant genes (second region). While the parents of Giza 75, Giza 45 and Giza 85 appeared to contain (0.50 – 0.25) of the dominant genes (third region).

Figure 3 shows that Giza 70, Giza77 and Giza45 contain most of the dominant gene fiber quality index. On other hand Giza 80 and Giza81 contain most of the recessive genes. While Giza 75 and Giza 85 appeared to contain (0.75- 0.050) of the dominant genes (second region). The parents Giza 83 and Giza 84 appeared to contain (0.50- 0.25) of the dominant genes (third region).

IMPLICATION IN COTTON BREEDING

The preponderonce of additive genetic varionce and low level of heterosis for attachment force and fuzz index are good indicators that selection in early generation would be effective. Thus, the conbination p2xp3 and p3 x p5 were good combinations to be induced in breeding programme for select in for low attachment force and low fuzz index strains.

The parent Giza84 is a good parent for low attachment force and low fuzz index.

Table 1. Mean squares of variance uniformity of W_r/V_r for validity assumption and Hoyman.

source	Attachment force	Fuzz index	Fiber quality index
Genotypes	774.27**	0.7269**	0.00199**
Error	84.23	0.0076	0.00011
T_2	0.1225	1.323	0.127
B	0.83	0.88	0.95
S_b	0.12	0.18	0.08

** Significant at the 1% probability level

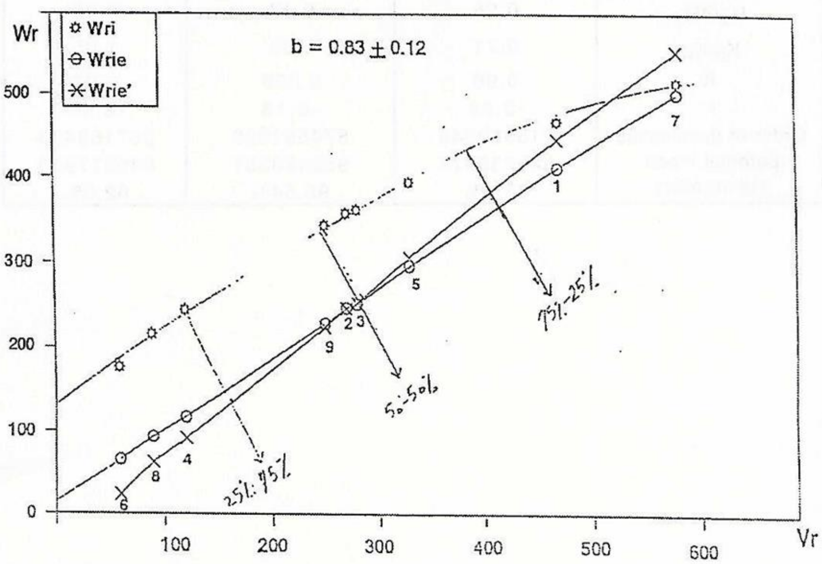
Table 2. The performance of each F_1 and its mid parents and estimates of heterosis relative to mid - parents.

	Fiber- attachment force			Fuzz index			Fiber quality index		
	Mid Parent	F_1 Performance	Heterosis %	Mid Parent	F_1 Performance	Heterosis%	Mid Parent	F_1 Performance	Hetcrosis %
P1xp2	79.44	67.06	-9.9	0.249	0.250	0.40	0.199	0.228	14.57*
P2	73.34	63.82	-12.98	0.176	0.180	2.27	0.198	0.216	9.09*
P4	85.19	117.28	37.67*	0.244	0.265	8.61	0.247	0.287	16.19*
P5	69.92	64.14	-8.27	0.171	0.205	19.8*	0.226	0.217	-0.40
P6	75.42	99.18	31.50*	0.299	0.348	16.39*	0.234	0.273	16.67*
P7	59.36	63.85	7.56	0.203	0.224	20.19*	0.211	0.229	8.53*
P8	85.93	101.58	18.21	0.302	0.204	5.15	0.254	0.282	11.02*
P9	60.70	98.26	61.87*	0.194	0.280	7.28	0.209	0.264	27.75*
P_2xP_3	89.62	63.85	-28.75	0.297	0.225	-24.24*	0.182	0.184	1.10
P4	101.47	116.00	14.32	0.365	0.325	-10.96*	0.231	0.295	27.71*
P5	86.20	68.41	-20.63*	0.292	0.273	6.51	0.210	0.221	5.23
P5	91.70	99.18	8.16	0.420	0.378	-10.00*	0.218	0.262	20.1*
P7	75.64	76.92	1.69	0.324	0.309	-4.60	0.195	0.233	19.49*
P8	102.21	79.69	-22.03*	0.315	0.308	-2.22	0.238	0.252	5.88
P9	60.23	63.43	5.33	0.423	0.368	-13.00*	0.193	0.215	11.40*
P_3xP_4	100.36	106.66	6.28	0.292	0.266	-8.90*	0.230	0.288	25.22*
P5	85.09	59.17	-30.46*	0.219	0.179	-18.26*	0.209	0.214	2.39
P6	90.59	89.24	-1.05	0.347	0.351	1.15	0.217	0.256	17.97*
P7	74.53	60.67	18.60	0.251	0.250	-0.04	0.194	0.220	13.40*
P8	101.10	90.56	-10.42	0.242	0.182	-24.79*	0.237	0.260	9.70*
P9	75.87	61.02	-19.57	0.350	0.310	-11.43*	0.192	0.227	18.23*
P_4xP_5	96.94	102.61	5.85	0.287	0.231	-19.51*	0.257	0.278	8.17*
P6	102.44	93.21	-9.01	0.415	0.448	7.95*	0.263	0.260	-1.14
P7	86.38	113.66	32.72*	0.319	0.349	9.40*	0.243	0.289	18.93
P8	112.95	99.75	-11.69	0.310	0.348	12.26*	0.286	0.257	-10.14*
P9	87.72	84.21	-4.00	0.418	0.419	0.24	0.241	0.262	8.71*
P_5xP_6	87.17	86.72	-0.52	0.342	0.400	16.96*	0.244	0.265	8.61*
P7	71.11	56.74	-20.21	0.256	0.201	-18.29*	0.222	0.226	1.80
P8	97.68	105.65	8.16	0.237	0.175	-26.16*	0.265	0.248	-6.42
P9	72.45	61.14	-15.61	0.345	0.304	-11.88*	0.220	0.208	-5.45
P_6xP_7	76.61	114.72	-49.75*	0.374	0.439	17.38*	0.230	0.286	24.35*
P8	103.18	95.71	-7.24	0.364	0.421	15.66*	0.273	0.267	-2.20
P9	77.95	102.25	31.17*	0.472	0.455	3.6	0.228	0.260	14.04*
P_7xP_8	87.12	99.77	14.52	0.269	0.313	16.36*	0.250	0.258	3.2
P9	61.89	57.74	-6.71	0.377	0.403	6.90*	0.205	0.210	2.44
P_8xP_9	88.46	87.68	0.88	0.367	0.372	1.36	0.248	0.253	2.02
L.S.D		16.01			0.023			0.018	
Mean of heterosis			-5.63		-1.51			8.98*	
N. of crosses			9		23			23	

* Significant crosses at 0.05 probability levels.

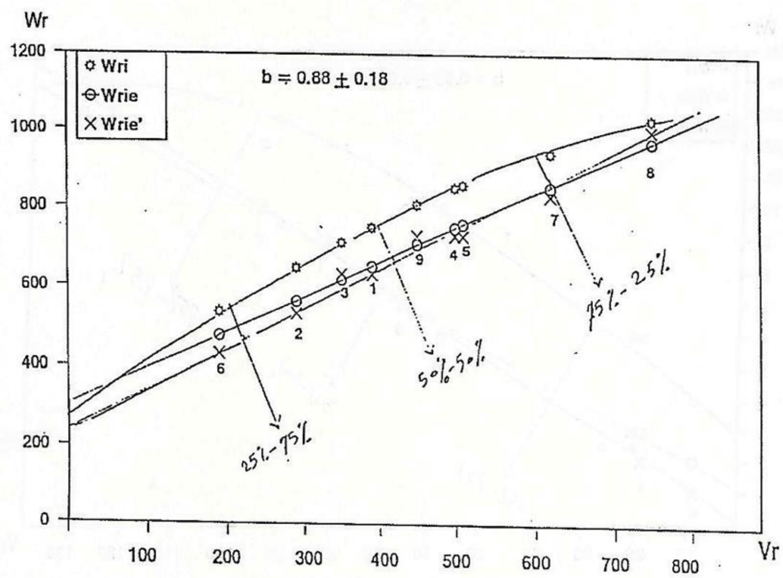
Table 3. The estimates of genetic variances components and genetic ratios

Component and Ratios	Fiber to seed attachment force	Fuzz index	Fiber quality inde
D	406.57±46.90	0.01387±0.0004	0.00155
F	-150.52±109.47	-0.00041±0.0008	0.00025
H_1	495.94±103.57	0.00425±0.0008	0.00130
H_2	504.2832±89.04	0.00277±0.0007	0.00133
h^2	48.32±59.65	-0.00010±0.0005	0.00142
E	42.11±14.8	0.00012±0.0001	0.000055
$(H_1/D)^{1/2}$	1.1	0.54	0.92
$H_2/4H_1$	0.25	0.17	0.25
K_D/K_R	0.71	0.95	1.05
K	0.96	0.036	1.07
r	-0.85	-0.18	-0.89
Order of domenance	715329846	874591326	237159486
parental mean	846235971	962478351	846517923
Heritability	62.0%	90.54%	62.0%



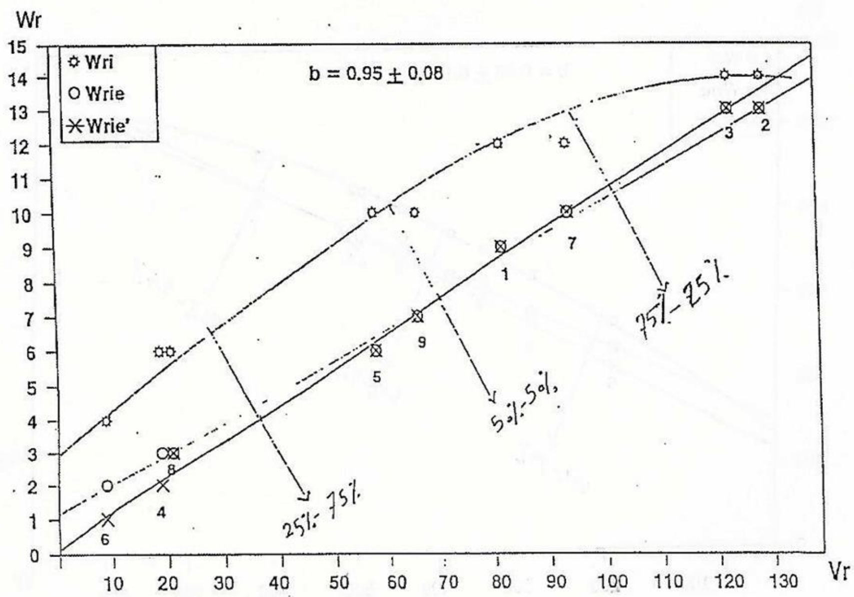
[(1) Giza 83, (2) Giza 81, (3) Giza 80, (4) Giza 45, (5) Giza 85, (6) Giza 70, (7) Giza 84, (8) Giza 77 and (9) Giza 75]

Fig. 1. Fiber attachment strength.



[(1) Giza 83, (2) Giza 81, (3) Giza 80, (4) Giza 45, (5) Giza 85, (6) Giza 70, (7) Giza 84, (8) Giza 77 and (9) Giza 75]

Fig. 2. Fuzz index.



[(1) Giza 83, (2) Giza 81, (3) Giza 80, (4) Giza 45, (5) Giza 85, (6) Giza 70, (7) Giza 84, (8) Giza 77 and (9) Giza 75]

Fig. 3. Fiber quality index.

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التحليل لهجن القطن بطريقة كل الهجن الممكنة .G. BARBADENSE L
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طلعت أحمد الفقي ، محمد عبد الباقي عبد الجليل

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يهدف هذا البحث إلى دراسة الفعل الجيني لصفات قوة تماسك الشعيرات ومعامل الزغب ومعامل الجودة. واستخدم في هذا البحث تسعة أصناف هي جـ٨٣، جـ٨١، جـ٨٠ ، جـ٤٥، جـ٧٠، جـ٨٤، جـ٧٧، جـ٧٥ وتم التهجين في نصف دائرة كاملة بين الأصناف السابقة بمحطة زراعة كلية الزراعة بالإسكندرية سنة ١٩٩٣ . في موسم عام ١٩٩٤ تم زراعة الآباء والهجن الناتجة في تجربة تصميم قطاعات كاملة العشوائية في مكررين في نهاية الموسم تم جني كل تركيب وراثي في كل مكرر على حدة وقسم محصول كل قطعة إلى جزأين أخذ منه ٥٠جم قطن زهر لقياس صفة قوة تماسك الشعيرات بالبذرة والجزء الثاني تم حلجه وأخذت ١٠٠ بذرة لتقدير معامل الزغب والشعيرات تم تقدير معامل الجودة لها.

وكانت أهم النتائج ما يلي:

١- كان للتأثير المضيف الدور الرئيسي في دراسة صفتي معامل الزغب ومعامل الجودة بينما في صفة قوة تماسك الشعيرات كان التأثيران المضيف والسيادي متساويان تقريبا.

٢- درجة السيادة جزئية في صفتي معامل الزغب ومعامل الجودة بينما كانت السيادة تفوقية إلى حد ما في صفة قوة تماسك الشعيرات بالبذرة.

٣- معظم الجينات السائدة تعمل في الاتجاه السالب لصفتي قوة تماسك الشعيرات ومعامل الزغب بينما تعمل الجينات السائدة في الاتجاه الموجب لمعامل الجودة.

٤- كانت الكفاءة الوراثية هي : ٦٢,٥٪ ، ٩٠,٥٤٪ ، ٦٢,٠٠٪ لصفات قوة تماسك الشعيرات بالبذرة ومعامل الزغب ومعامل الجودة على التوالي.

٥- كان معامل الانحدار W_r / V_r في الجيل الأول لا يختلف عن الوحدة معنويا مما يدل على وجود الأثر المضيف مع الأثر السيادي.

٦- من توزيع الأصناف على خط الانحدار يتضح أن الصنف جـ ٧٠ يعتبر أفضل الأصناف للصفات المدروسة.