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ESTIMATION OF HETEROSIS, GENE ACTION, HERITABILITY AND GENETIC ADVANCE IN EGYPTIAN COTTON (*Gossypium barbadense L.*)

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ABSTRACT: *Six generations P_1, P_2, F_1, F_2, BC_1 and BC_2 carried out at the Experimental Farm, Faculty of Agriculture, Minofiya University at Shebin El-Kom during the three successive seasons 2009, 2010 and 2011 to evaluate genetic variance and detecting epistatic variation in two crosses i.e. Giza 92 × Giza 45 (cross I) and Giza 90 × Giza 80 (cross II). The means of the six generations recorded for days to first flower, plant height, number of fruiting branches per plant, number of open bolls per plant, boll weight, lint percentage, seed index, seed cotton yield, lint yield and lint index, were subjected to six parameters method to detect epistasis and estimates of m, a, d, aa, ad and dd parameters. Results showed that the genetic variance within F_2 populations were found to be significant for all traits in the two crosses investigated. The results revealed that the epistatic gene effect cannot be ignored when establish a new breeding programe to improve cotton populations for economic traits. The inheritance of all studied traits was controlled by additive and non-additive genetic effects. Consequently, it could be concluded that selection procedures based on the accumulation of additive effects would be successful in improving all traits studied. However, to maximize selection advance, procedures which are known to be effective in shifting gene frequency when both additive and non-additive genetic variances are involved would be preferred. Heterobeltiosis was found to be significantly positive for number of open bolls per plant, boll weight, seed index, lint yield per plant and lint index in the two crosses, and plant height, number of fruiting branches and seed cotton yield per plant in cross II. Inbreeding depression values estimated here were found to be highly significant and positive for boll weight, seed index and lint index in each of cross I and cross II, number of fruiting branches in cross I and plant height, number of open bolls per plant and lint yield per plant in cross II. However, it was high significant and negative for seed cotton yield per plant in the two cotton crosses, number of open bolls per plant and lint yield per plant in cross I, days to first flower in cross II. High genetic gain was found to be associated with high narrow sense heritability estimates for plant height, number of fruiting branches per plant, numbers of open and bolls per plant, boll weight, seed index, seed cotton yield and lint index in each of the first and second crosses and lint yield per plant in the second cross. Therefore, selection for these straits should be effective and satisfactory for successful breeding proposes.*

Key words: *Egyptian cotton, six population analysis, gene action, heterosis, inbreeding depression, heritability.*

INTRODUCTION

Egyptian cotton is one of the most important industrial, social, and economic crops as it plays a vital role in our industrial and agricultural development. In recent years, the total cultivated area began to decline, in 2012 cotton was sown on an area of 333 thousand feddan with production of

294 thousand ton which was less than previous years. Furthermore, the government failed in put market mechanisms of cotton crop and dropped its plan to increase cultivated areas of it, indicated that there is a marked deterioration in Egyptian cotton. This requires much efforts to increase the production of unit area in order to compensate for the shortfall in the cultivated area.

Knowledge of the genetic variance components and type of gene action controlling yield, its components and quality would help in understanding the genetic basis of the traits studied and formulation of systematic breeding program for improving this crop or any other crops. Different biometrical techniques viz., have been developed which provide information about additive and dominance genetic variances and fail to produce information about epistasis variance because their procedures are based on certain genetically basis. Assumptions including absence of non-alleleic interactions (Mather & Vines, 1952; Ospal, 1956; Singh and Singh, 1976). Some other biometrical tools viz. six populations (Hayman,1958; Jinks & Jones 1958), triple test cross (Hayman,1958; Jinks & Jones 1958) provide reliable information about the presence or absence of epistasis, where estimates of all three components of genetic variance i.e. additive, dominance and epistasis variance. In self-pollinated species like cotton, epistasis is perhaps more important to breeders than dominance, because the later is necessarily ephemeral in such species. Also, epistasis can also be partitioned into three components i.e., additive × additive, additive × dominance and dominance × dominance (Hayman and Mather, 1955). On the other hand, heterosis is an important genetic tool to facilitate yield enhancement and help enrich many other desirable quantitative and qualitative traits.

Generally, results indicated that the additive gene effect were more in the genetic control of most yield characters. The prevalence of additive gene effect may be suggest that selection in early segregating generations would be effective for improving these characters. While, if dominance genetic variance was played a great role in the inheritance of some yield characters. Therefore, population improvement through hybrid procedures might be gives a good response. When, both additive and non-additive gene action i.e. dominance and epistasis were controlled in the inheritance of some traits. Consequently, selection procedures (recurrent selection) based on the accumulation of additive effect would be successful in improving all traits under investigation. However, to maximize selection advance, procedures which are known to be effective in shifting gene frequency when both additive and non-additive genetic variance are involved would be preferred. However, results showed that epistasis components played a great role in the inheritance of most yield characters studied, and resulted unbiased estimation of additive and dominance genetic variance. Thus, ignoring such effect in cotton population one would loss information about epistasis but also the estimates of additive and dominance would be biased. Thus, the breeder should take epistasis into account in producing genetic models for studying quantitatively inherited characters. The objectives of the present study are to establish: (i) The potentiality of heterosis expression for seed cotton yield and some of its components; (ii) The genetical behaviour, heritability and expected genetic advance under selection for seed cotton yield and some agronomic traits in the two crosses, Giza 92 × Giza 45 and Giza 90 × Giza 80.

MATERIALS AND METHODS

This experiment was carried out at the experimental farm, Faculty of Agriculture, Minufiya University at Shebin El-Kom during the three successive seasons 2009, 2010 and 2011. to evaluate gene action and detecting epistatic variation of the cotton varieties in two crosses i.e. Giza 92 × Giza 45 and Giza 90 × Giza 80. Origin and characteristics of the cotton parental genotypes are presented in Table (1).

The two intial crosses Giza 92 x Giza 45 and Giza 90 x Giza 80, designated in the text as first and second cross; respectively, were made in 2009 growing season, F_1 plants were self pollinated and backcrossed to both respective parents to obtain F_2 and backcross seeds in 2010 growing season. The six populations P_1, P_2, F_1, F_2, Bc_1 and Bc_2 of each cross were sown in 2011 using randomized complete block design with three replicates. Each block comprised 25 rows of F_2, 10 rows of each of Bc_1 and Bc_2 and 5 rows of any non-segregated populations. Each row included 15 hills spaced at 20 cms. Apart within ridges of 60 cms. Seedling were later thinned to two plants per each hill. Normal agricultural cotton practices were applied as usual for the ordinary cotton fields in the area of study. Data were recorded on an individual guarded plant of the six populations for each cross where 20, 20, 25, 200, 120 and 120 plants were chosen from P_1, P_2, F_1, F_2, BC_1 and BC_2 of each cross, respectively, to collect the following traits: days to first flower, plant height, number of fruiting branches per plant, number of open bolls per plant, boll weight, lint percentage, seed index, seed cotton yield, lint yield and lint index.

Table (1): Origin and characteristics of the cotton parental genotypes.

No	Name	Origin	Characteristics
1	Giza 92	Egyptian variety Giza 84 (Giza74 × Giza68)	New Egyptian variety, early in maturity, resistant to lodging, extra long staple, fineness and strong lint.
2	Giza 45	Egyptian variety (Giza 28× Giza 7)	Late in maturity, low lint yield, low boll weight as well as lint percentage, an extra long staple, extra fine and strong (the best variety for fibre quality)
3	Giza 90	Egyptian variety (Giza 83× Dandra)	Crossing from Giza 83 with Dandra to replace Giza 83 in the governorates of south valley, tolerant to heat, early in maturity, high in yield characters, lowest Egyptian varieties for fibre quality.
4	Giza 80	Egyptian variety (Giza 66× Giza 73)	Crossing from Giza 66 with Giza 73 to replace Giza 75 in northern governorates of upper Egypt, higher than Giza 75 in high in yield characters as well as lint percentage, but shorter than in staple, strength and brightness.

Statistical procedures used herein would only be computed if the F_2 genetic variance was found to be significant. A one tail "F" ratio was used to examine the existence of genetic variance within the F_2 population. The degrees of freedom for this test was considered as infinity. If calculated "F" ratio was equal to or larger than the tabulated ones, various biometrical parameters needed in this investigation would be computed. Heterosis (H), was expressed as percent increase of the F_1 mean performance above the respective better parent, i.e. (F_1 – B.P)/B.P. x 100. Inbreeding depression (I.D) was measured as the average percent decrease of the F_2 from the F_1. F_2 deviation (E_1), was calculated as the deviation of the F_2 mean performance from the average of F_1 and mid-parent value (Marani, 1968). Backcrosses deviation (E_2), was computed as the deviation of the two backcrosses performance from the F_1 and mid-parent performances (Marani, 1968) .Nature and degree of dominance were determined by means of potence ratio method (P) which can be defined as the average dominance of the whole gene set of one parent or the other (Petr and Frey, 1966). Nature of gene action was studied according to the relationships illustrated by Gamble (1962). In this procedure the means of the six populations of each cross were used to estimate six parameters of gene action. Heritability was estimated in both broad and narrow senses for F_2 generation, according to Mather's procedure (1949). The predicted genetic advance under selection (ΔG) was computed according to Johnson *et al.* (1955).

RESULTS AND DISCUSSIONS

The genetic variances within F_2 populations were found to be significant for all studied traits i.e. days to first flower, plant height, number of fruiting branches per plant, number of open bolls per plant, boll weight, lint percentage, seed index, seed cotton yield, lint yield and lint index in the two cotton crosses. Consequently, the various genetical parameters used in this investigation were estimated for all traits studied.

The existence of the significant genetic variability in F_2 population in spite of the insignificant differences between the parental cultivars for most traits measured, may suggest that the genes of like effects were not completely associated in the parental cultivars, i.e. these genes are dispersed (Mather and Jinks, 1982). Means and variances of the six populations P_1, P_2, F_1, F_2, Bc_1 and Bc_2 for all traits studied in the two cotton crosses are presented in Table (2).

1. Heterosis:

Heterosis relative to better parent was found to be significantly positive for number of open bolls per plant, boll weight, seed index, lint yield per plant and lint index in the two crosses, days to first flower in the first cross and plant height, number of fruiting branches per plant and seed cotton yield per plant in the second cross (Table 3). Similar finding was also recorded in cotton by Dawwam *et al*., (2009), Balu *et al*., (2012) and Muhammad *et al*., (2014). However, significantly negative heterosis was found for only number of fruiting branches and lint percentage in the first cross. Soomro *et al*., (2006) and Ranganatha *et al.,* (2013) found similar results.

2. Inbreeding depression:

Inbreeding depression (%) is measured as the percent deviation of F_2 from F_1 mean performance (Table 3). Inbreeding depression values estimated here were found to be highly significant and positive for boll weight, seed index and lint index in each of cross I and cross II, number of fruiting branches in cross I and plant height, number

Table 2

Table 3

of open bolls per plant and lint yield per plant in cross II. However, it was high significant and negative for seed cotton yield per plant in the two cotton crosses, number of open bolls per plant and lint yield per plant in the first cross, days to first flower in the second cross. The coincidence of sign of heterosis and inbreeding depression was detected in most cases. This is logic and expected since the expression of heterosis in F_1 will be followed by a considerable reduction in F_2 due to homozygosity. The contradiction between heterosis and inbreeding depression was detected for number of fruiting branches per plant, number of open bolls per plant and lint yield in the cross I and seed cotton yield in the cross II could be due to the presence of linkage between genes in these plant materials.

Similar results relative to heterosis and inbreeding depression was obtained by Esmail (2007) detected that the coincidence of sign and magnitude of heterosis and inbreeding depression was found for most traits in the two cotton crosses (Mc-Naire 235 x Nazilli-m55) and (Giza 70 x S.8017). El-Refaey and El-Razek (2013) concluded that heterosis over mid and better parent were highly significant in all crosses for no. of bolls/plant, seed and lint cotton yields/plant with low inbreeding depression.

3. Potence ratio:

The average degree of dominance as indicated by the potence ratio revealed the existence of over-dominance towards the better parent for number of open bolls per plant, boll weight, seed index, lint yield per plant and lint index in each of the two crosses and plant height, number of fruiting branches per plant, lint percentage and seed cotton yield per plant in cross II Table (3). While Partial dominance towards the higher parent was found for days to first flower in each of cross I and cross II, plant height, number of fruiting branches per plant, lint percentage and seed cotton yield per plant in the first cross. Hussain *et al*., (2008), Latif *et al*., (2014) and Ekinci and Basbag (2015) found similar results.

4. F2 – deviation (E_1):

F_2 – deviation for all traits studied in the two cotton crosses are presented in Table (3). F_2 mean performance was found to deviate significantly from the average of the F_1 and mid-parent value E_1 for seed index and seed cotton yield in each of cross I and cross II, number of open bolls per plant and lint yield in cross I and days to first flower and plant height in cross II. The highly expressive of F_2-deviation (E_1) would indicate the presence of epistasis in the inheritance of these traits.

5. Backcross deviation (E_2):

Backcross deviation for all traits studied in the two cotton crosses under investigation are presented in Table (3). When no effects of epistasis are assumed, backcross performance would be expected to be near the average of F_1 and recurrent parent performance. Appreciable deviation from this expected value, however, will be observed if epistasis is found to be operated in the inheritance of the trait.

Backcross deviation (E_2) was found to be significant for number of fruiting branches per plant and seed index in two cotton crosses, lint percentage and seed cotton yield in cross I and days to first flower, plant height, boll weight, lint yield and lint index in cross II.

Also, the F_2-deviation was accompanied by backcross deviation in some cases, indicating the presence of epistasis in such large magnitude as to warrant great deal of attention in a breeding program to improve these traits.

6. Nature of gene action:

Genetical analysis of generation means to give estimates of mean effect parameter (m), additive (a), dominance (d), the three epistatic types additive x additive (aa), additive x dominance (ad) and dominance x dominance (dd) were calculated according to the relationships illustrated by (Gamble 1962). The estimated values of the various types of gene effects are presented in Table (3).

The estimated mean effects parameter (m) which reflect the contributed due to the over all mean plus the locus effects and interaction of the fixed loci were found to be highly significant for all traits studied in the two cotton crosses under investigation indicating that these traits were mainly quantitatively inherited.

The additive gene effects (a) were found to be significant for number of fruiting branches per plant in the two cotton crosses under investigation, days to first flower and lint percentage in cross I and number of open bolls per plant, seed index and lint yield per plant in cross II. Suggesting the potential for obtaining further improvements of these traits.

Dominance gene effects (d) were found to be significant for seed cotton yield in each of cross I and cross II, number of open bolls per plant, seed index and lint index in cross I and number of fruiting branches per plant in cross II, suggesting that the dominance factors play a great role in the inheritance of these traits.

Additive x additive (aa) epistatic type of gene effects were found to be significant for seed cotton yield in the first and second crosses, number of open bolls per plant and lint percentage in cross I and number of fruiting branches per plant in cross II.

Additive x dominance type of digenic epistatic effects (ad) played a major role in the inheritance of number of open bolls per plant, boll weight and seed cotton yield per plant in the second cross, while days to first flower, plant height, number of fruiting branches per plant, lint percentage, seed index, seed cotton yield and lint index showed no significant in each of cross I and cross II.

The dominance x dominance epistatic effect (dd) played major role in the inheritance of number of fruiting branches per plant in the first and second crosses, number of open bolls per plant and lint percentage in cross I and days to first flower, plant height, seed index and seed cotton yield in cross II. Similar finding was also recorded in cotton by Mehetre *et al*., (2004), Esmail (2007), Hussain *et al*., (2008) Dawwam *et al*., (2009), Abd-El-Haleem *et al*., (2010), Nidagundi *et al*., (2012), Kannan *et al*., (2013) and Patel *et al.,* (2014).

It is worth to mention that the three epistatic types aa, ad and dd were found to be accompanied by significant estimates of both E_1 and E_2 epistatic scales in most traits studied and that would ascertained the presence of epistasis in such large magnitude as to warrant great deal of attention in cotton breeding programs. Also, the heterotic effects previously mentioned could be due to both dominance and epistasis. The presence of both additive and non-additive gene action in mostly all traits studied would indicate that selection procedures based on the accumulation of additive effects should be successful in improving all traits under investigation. However, to maximize selection advance, procedures which are known to be effective in shifting gene frequency when both additive and non-additive genetic variances are involved would be preferred.

Similar results were previously reported by Esmail (2007) reported that the inheritance of all traits studied was controlled by additive and non-additive genetic effects, Singh et al., (2008) showed that importance of additive as well as non-additive gene effects in the inheritance of different characters, Singh et al., (2009) indicated that the magnitude of additive genetic component was higher than dominance genetic component for plant height, boll weight and seed index, it is suggested that selection in early segregating generations would be effective, while, if the non-additive portion is larger than additive, the improvement of the characters need intensive selection through later generation, when epistatic effects were significant for traits, the possibility of obtaining desirable segregates through intermating in early generations and suggest to adopt recurrent selection for handling the above crosses for rapid improvement.

7. Heritability and genetic advance:

Heritability in both broad and narrow senses and genetic advance under selection are presented in Table (4). High heritability estimates in broad sense were obtained for numbers of open bolls per plant and seed cotton yield in each of crosses, days to first flower and plant height in the first cross and number of fruiting branches per plant in the second cross. Moderate estimates of broad sense heritability were obtained for lint yield per plant in each of crosses and seed index in cross I, days to first flower and lint percentage in cross II. Low values of broad sense heritability were obtained for boll weight and lint index in the two crosses studied, number of fruiting branches per plant and lint percentage in cross I and seed index in cross II

Esmail (2007) and Batool *et al.,* (2010) found similar results. Narrow sense heritability estimates were found to be high in plant height, number of fruiting branches per plant, numbers of open bolls per plant, boll weight, lint percentage, seed index, seed cotton yield and lint index in each of the first and second crosses and lint yield per plant in the second cross. Low values of narrow sense heritability were detected for days to first flower in each of the two crosses and lint yield per plant in the first cross. Dawwam *et al*., (2009) and Nassar (2013) found similar results.

Genetic advance under selection which are given in Table (4) show the possible gain from selection as percent increase in the F_3 over the F_2 mean when the most desirable 5 % of the F_2 plants are selected. Genetic advance under selection (AG %) was found to be high in magnitudes for all crosses studied except days to first flower and lint percentage in the two cotton crosses under investigation.

Johnson *et al.* (1955) reported that heritability estimates along with genetic gain upon selection were more valuable than the former alone in predicting the effect of selection. On the other hand, Dixit *et al.* (1970) pointed out that high heritability is not always associated with high genetic advance, but in order to make effective selection, high heritability should be associated with high genetic gain.

In the present investigation, high genetic gain was found to be associated with high narrow sense heritability estimates for plant height, number of fruiting branches per plant, numbers of open and bolls per plant, boll weight, seed index, seed cotton yield and lint index in each of the first and second crosses and lint yield per plant in the second cross. Therefore, selection for these straits should be effective and satisfactory for successful breeding proposes. While moderate estimates of narrow sense heritability and high or moderate genetic advance were obtained for lint yield per plant in cross I.

Table (4): Heritability, estimates, genetic advance (∆ g) and genetic advance expressed as a percentage of the F_2 mean (∆ g %) in the two cotton crosses for yield and some agronomic traits.

Characters	Cross	Heritability (%)		Genetic advance	
		Broad sense	Narrow Sense	∆ g	∆ g%
Days to first flower	I	59.17	28.02	1.65	2.12
	II	46.97	37.96	2.21	2.8
Plant height (cm)	I	69.33	97.99	41.87	33.81
	II	41.16	87.85	30.64	29.81
No. of fruiting branches per plant	I	25.06	56.01	3.36	23.93
	II	50.19	93.96	6.20	41.58
No. of open bolls per plant	I	58.91	81.99	11.04	77.05
	II	54.38	53.97	5.9	51.61
Boll weight (g)	I	37.43	63.32	0.6	24.23
	II	26.45	81.33	0.74	31.33
Lint percentage (%)	I	20.63	69.22	3.22	9.07
	II	42.18	77.39	3.71	9.2
Seed index (g)	I	40.15	67.92	1.41	14.6
	II	36.59	91.82	1.98	20.09
Seed cotton yield per plant (g)	I	73.00	87.49	33.9	95.54
	II	50.79	99.73	33.77	79.69
Lint yield per plant (g)	I	47.83	42.27	5.83	46.52
	II	47.42	87.41	11.35	98.89
Lint index (%)	I	37.05	61.32	1.30	24.23
	II	19.27	64.90	1.31	19.51

Consequently, selection for these traits would be effective, but probably of less success than in the former characters. Relatively low narrow sense heritability was associated with moderate or low estimates of genetic gain for days to first flower in cross I and cross II, hence selection procedures for these traits would be of less effectiveness.

Similar results were obtained by Ahmed *et al.*, (2006) who indicated that plant height and seed cotton yield per plant displayed moderate to high estimates of heritability and genetic advance which is indicative of additive with partial dominance type of gene action suggesting the feasibility of selection in the early generation. Bolls per plant and boll weight exhibited moderate to high heritability and low genetic advance which indicated over dominance type of gene action thereby revealing that selection might be useful if delayed. Esmail (2007) reported high heritability was associated with high genetic advance in number of open bolls per plant, seed cotton yield and lint yield, proving the presence of sufficient genetic variability which help the cotton breeder to exploit it by practice most effective selection in early generations. Reddy and Reddy (2011) revealed that seed, cotton yield showed high heritability and high genetic advance which are due to additive gene effect and selection is rewarded. Moderate heritability coupled with moderate genetic advance was observed for bolls/plant, boll weight and ginning percentage indicating the operation of both additive and non additive gene action in the inheritance of these traits. Plant height, monopodia and locules/plant, seed index showed low heritability as well as low genetic advance besides narrow range of variability restricting the scope for improvement through selection.

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تقدير قوة الهجين و الفعل الجينى و الكفاءة الوراثية و التحسين الوراثى فى القطن المصرى

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الملخص العربي

أجرى هذا البحث في مزرعة كلية الزراعة بشبين الكوم . جامعة المنوفية وذلك في الثلاثة مواسم المتتالية ٢٠٠٩ ، ٢٠١٠ ، ٢٠١١ لدراسة التباينات الوراثية وتقدير الفعل الوراثى التفوقى فى القطن باستخدام الهجينين (جيزة ٤٥ xجيزة ٩٢) , (جيزة ٩٠ x جيزة ٨٠) باستخدام طريقة العشائر الستة وهى طريقة فعالة لاختبار التفاعل الغير اليلى وتجزئته الى مكوناته وذلك لكل من صفات ; عدد الأيام من الزراعة حتى ظهور أول زهرة . طول النبات . عدد الأفرع الثمرية على النبات . عدد اللوز المتفتح على النبات . متوسط وزن اللوزة . محصول القطن الزهر. محصول القطن الشعر . وزن ١٠٠ بذرة و تصافى الحليج . معامل الشعرة.

ويمكن إيجاز أهم النتائج المتحصل عليها مما يلى :

١– وقد أظهرت النتائج وجود اختلافات وراثية معنوية في عشائر الجيل الثاني لجميع الصفات تحت الدراسة.

٢- كذلك وجد ان التفوق يشكل أهمية عالية فى وراثة أغلب الصفات المدروسة وبالتالى لا يمكن تجاهله ومن الأهمية تقديره وقياسه وآخذة فى الاعتبار عند وضع برامج التربية لتحسين هذه الصفات حيث أن هذا المكون أهم من السيادة فى محاصيل ذاتية التلقيح مثل القطن.

٣- كما وجد أن التباين الوراثى المضيف والغير مضيف يتحكم فى وراثة كل الصفات المدروسة وبالتالى فإن عمليات الإنتخاب المبنية على تراكم التباين الوراثى المضيف ستكون مفيدة فى تحسين هذة الصفات ولكن لزيادة التحسين الوراثى الناتج عن الانتخاب فإن طرق التربية التي تعتمد على وجود التباين الوراثى المضيف والغير مضيف مثل الإنتخاب المتكرر سوف تكون هى الأفضل.

- كانت قوة الهجين بالنسبة للأب الأعلى موجبة ومعنوية لكلا من صفات عدد اللوز المتفتح على النبات ، متوسط وزن اللوزة ، دليل البذرة ، محصول النبات من القطن الشعر ، معامل الشعرة فى كلا الهجينين و عدد الأيام من الزراعة حتى ظهور أول زهرة فى الهجين الاول و طول النبات ، عدد الأفرع الثمرية على النبات ، محصول النبات من القطن الزهر فى الهجين الثانى. بينما كانت قوة الهجين سالبة ومعنوية لصفتى عدد الأفرع الثمرية , تصافى الحليج فقط فى الهجين الاول.
- كان تأثير التربية الداخلية موجباً و معنوي للصفات متوسط وزن اللوزة ، دليل البذرة ، معامل الشعرة فى كلا الهجينين و عدد الأفرع الثمرية على النبات فى الهجين الاول و طول النبات ، عدد اللوز المتفتح على النبات ، محصول النبات من القطن الشعر فى الهجين الثانى. بينما كان تأثير التربية الداخلية معنوياً وسالباً فى محصول النبات من القطن الزهر فى كلا الهجينين و عدد اللوز المتفتح على النبات ومحصول النبات من القطن الشعر فى الهجين الأول و عدد الأيام من الزراعة حتى ظهور أول زهرة فى الهجين الثانى.
- أظهرت النتائج أن القيم العالية للنسبة المئوية للتحسين الوراثى المتوقع بالإنتخاب مصاحبة للقيم العالية لدرجة التوريث بالمعنى الدقيق لصفات طول النبات وعدد الفروع الثمرية وعدد اللوز المتفتح على النبات و متوسط وزن اللوزة ودليل البذرة ومحصول القطن الزهر في كلا الهجينين الأول والثانى ومحصول النبات من القطن الشعر فى الهجين الثانى مما يؤكد ان الانتخاب لهذه الصفات يكون فعالا وناجحا فى برامج تربية وتحسين هذه الصفات.

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Table (2): Means ($\bar{X}$) and variances (S2) of P_1, P_2, F_1, F_2, BC_1 and BC_2 populations and F-test of significance of the genetic variance in F2 populations for all traits studied in the two cotton crosses i.e., (Giza 92 x Giza 45) and (Giza 90 x Giza 80)

Characters	cross	F-test		Cross I						Cross II					
				Giza 92	Giza 45	F_1	F_2	Bc_1	Bc_2	Giza 90	Giza 80	F_1	F_2	Bc_1	Bc_2
Days to first flower	I	**	$\bar{x}$	76.60	80.00	77.89	78.00	76.16	78.77	75.75	78.50	76.10	78.72	78.40	79.30
	II	*	S^2	4.93	2.00	3.11	8.20	7.25	6.85	6.41	3.00	3.25	7.96	6.36	6.54
Plant height (cm)	I	**	$\bar{x}$	125.13	122.74	126.85	123.83	125.17	120.80	102.68	110.50	124.91	102.78	103.92	101.32
	II	*	S^2	127.70	162.43	105.82	430.26	206.73	232.17	184.96	163.00	157.99	286.63	145.74	175.71
No. of fruiting branches per plant	I	*	$\bar{x}$	11.50	18.45	15.04	14.05	12.35	14.81	14.14	13.44	14.85	14.91	14.24	13.09
	II	*	S^2	4.79	6.89	7.42	8.50	5.67	6.56	5.63	3.40	6.31	10.26	5.89	4.99
No. of open bolls per plant	I	**	$\bar{x}$	9.59	10.27	11.00	14.33	9.43	11.50	10.80	10.75	13.84	11.43	13.25	9.86
	II	**	S^2	12.82	15.54	24.33	42.75	22.87	27.57	10.36	8.59	19.60	28.17	23.42	17.71
Boll weight (g)	I	*	$\bar{x}$	2.31	2.29	2.57	2.49	2.55	2.45	2.26	2.52	2.54	2.36	2.37	2.33
	II	*	S^2	0.16	0.09	0.15	0.21	0.18	0.11	0.11	0.17	0.15	0.19	0.10	0.13
Lint percentage (%)	I	*	$\bar{x}$	36.65	34.17	35.45	35.57	37.26	35.41	39.77	40.25	40.37	40.34	40.07	40.38
	II	*	S^2	4.26	3.92	4.00	5.11	3.89	2.79	3.05	3.61	2.75	5.42	3.71	2.94
Seed index (g)	I	*	$\bar{x}$	9.57	9.76	10.85	9.69	9.66	10.03	9.98	10.20	10.40	9.87	9.58	9.95
	II	*	S^2	0.71	0.71	0.42	1.02	0.76	0.59	0.66	0.88	0.55	1.10	0.54	0.65
Seed cotton yield per plant (g)	I	**	$\bar{x}$	20.52	22.47	22.46	35.48	25.43	30.23	22.80	22.28	25.23	42.38	25.57	28.23
	II	**	S^2	83.56	92.05	110.90	353.75	187.28	210.72	71.02	200.02	127.86	270.19	115.02	155.91
Lint yield per plant (g)	I	*	$\bar{x}$	8.08	8.26	9.97	12.54	10.09	11.33	10.15	10.62	14.59	11.48	12.11	9.52
	II	**	S^2	20.70	14.37	35.21	44.91	34.61	36.23	15.90	18.77	27.99	39.73	26.28	18.45
Lint index (%)	I	*	$\bar{x}$	5.42	5.07	5.88	5.37	5.75	5.44	6.59	6.80	7.00	6.70	6.42	6.71
	II	*	S^2	0.71	0.70	0.59	1.06	0.81	0.66	0.76	0.93	0.62	0.96	0.56	0.73

Table (3): Heterosis, inbreeding depression, potence ratio, F2 – deviation (E1), backcross deviation (E2) and gene effects parameters in the two crosses i.e., (Giza 92 x Giza 45) and (Giza 90 x Giza 80) for yield and some agronomic traits.

Characters	Cross	Heterosis (%)	Inbreeding depression Id.	Potence Ratio	E_1	E_2	Gene effects parameters					
							m	a	d	Aa	Ad	dd
Days to first flower	I	2.22**	0.38	0.24	-0.09	-1.26	78.00**	-3.14**	-2.55	-2.14	-0.91	4.66
	II	0.46	-3.45**	0.75	2.11**	4.47**	78.72**	-0.90	-0.52	0.50	0.48	-9.45*
Plant height (cm)	I	1.37	2.38	2.43	-1.56	-4.81	123.83**	4.37	-0.48	-3.39	3.17	13.02
	II	13.04**	17.72**	4.68	-12.97**	-26.26**	102.78**	2.60	17.69	-0.63	6.51	53.14**
No. of fruiting branches per plant	I	-18.50**	6.54**	0.02	-0.95	-2.85**	14.05**	-2.45**	-1.83	-1.89	1.02	7.60*
	II	5.02**	-0.39	3.03	0.59	-1.32*	14.91**	1.15*	-3.93*	-4.99**	0.80	7.63**
No. of open bolls per plant	I	7.08**	-30.30**	3.13	3.87**	0.002	14.33**	-2.07	-14.40**	-15.47**	-1.73	15.46*
	II	28.13**	17.41**	115.07	-0.88	-1.51	11.43**	3.49**	3.55	0.48	3.37**	2.54
Boll weight (g)	I	11.39**	3.19**	32.21	0.05	0.13	2.49**	0.10	0.32	0.04	0.09	-0.30
	II	0.99**	7.25**	1.20	-0.11	-0.24*	2.36**	0.04	0.11	-0.04	0.17*	0.51
Lint percentage (%)	I	-3.28**	-0.34	0.03	0.14	1.80*	35.57**	1.85**	3.09	3.05*	0.61	-6.66*
	II	0.30	0.08	1.51	0.15	0.08	40.34**	-0.31	-0.08	-0.44	-0.07	0.29
Seed index (g)	I	11.09**	10.64**	12.01	-0.56**	-0.82**	9.69**	-0.37	1.79**	0.61	-0.28	1.04
	II	1.96**	5.03**	2.81	-0.37**	-0.95**	9.87**	-0.37*	-0.13	-0.44	-0.26	2.34**
Seed cotton yield per plant (g)	I	-0.06	-57.99**	0.99	13.50**	11.70**	35.48**	-4.80	-29.65*	-30.62*	-3.82	7.22
	II	10.64**	-67.99**	10.41	18.49**	6.04	42.38**	-2.66	-59.21**	-61.89**	-2.92	49.81**
Lint yield per plant (g)	I	20.78**	-25.76**	20.76	3.47**	3.27	12.54**	-1.23	-5.53	-7.34	-1.15	0.79
	II	37.43**	21.35**	18.11	-1.01	-3.35*	11.48**	2.59*	1.55	-2.66	2.82**	9.37
Lint index (%)	I	8.50**	8.72**	3.64	-0.20	0.06	5.37**	0.30	1.53**	0.89	0.13	-1.01
	II	2.93**	4.26**	2.93	-0.15	-0.57*	6.70**	-o.29	-0.24	-0.54	-0.19	1.98

*, ** Significant at 0.05 and 0.01 levels of probability, respectively