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GENETICAL STUDIES ON YIELD AND ITS COMPONENTS IN AN EGYPTIAN COTTON CROSS, (GIZA 85 X GIZA 90)

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ABSTRACT

This investigation was carried out at Giza Experimental Station, Agricultural Research Center, during the three successive seasons (2003 – 2005) to study the heterosis, genetic parameters, heritability in broad and narrow sense and genetic advance for yield, its components and earliness in an Egyptian cotton cross of Giza 85 x Giza 90.

Results show that the F1 exceeded the higher parent for all studied traits except boll weight and position of first fruiting node. Heterosis effects relative to better parent and mid – parents were positive and significant for seed cotton yield per plant, lint yield per plant, boll weight, lint percentage %, seed index and number of harvested bolls per plant. On the other hand, negative and high significant were observed for days to first flower and days to first opening boll traits. While position of first fruiting node and earliness % recorded highly significant negative heterotic effects relative to better parent. The inbreeding depression values were significant and negative for seed cotton yield per plant and days to first opening bolls. Potence ratio, over dominance values were obtained for most traits except for boll weight, position of first fruiting node and earliness % that showed partial dominance. Significant and positive additive gene effects were found for position of first fruiting node, days to first flower and days to first opening bolls, while it was negative significant for the other characters except seed index. Dominance gene effect was positive and significant for lint percentage %.

The non-additive components were greater in magnitude than additive component for most traits. Additive x additive type of epistasis values was significant and highly significant for all studied characters except seed index, position of first fruiting node and days to first flower. High values for broad sense heritability were detected for seed cotton yield per plant, lint yield per plant, days to first opening bolls, number of harvested bolls per plant and earliness %, but moderate values for broad sense heritability were detected for the other traits. Moderate narrow sense heritability values were recorded for the most traits.

The expected genetic advance values for selecting the higher 5% of F2 population were 18.70, 17.73, 16.28 and 14.77 % for number of harvested bolls per plant, lint yield per plant, boll weight and seed cotton yield per plant, respectively.

It could be concluded that the improvement of position of first fruiting node position of first fruiting node could be achieved in early segregating generations, but other characters needs intensive selection through later generations.

INTRODUCTION

Cotton has played an important role in the economy of Egypt. Improvement of yield, its components and fiber quality of cotton varieties is the main goal of cotton breeders. The breeder's interest is to develop early mature and high yielding cotton varieties possessing other desirable fiber characteristics. Therefore, the genetic analysis of different characters in segregating generations could help the breeder to establish the most effective methods to incorporate desirable characters in the new varieties.

The present investigation deals with the estimation of heterosis, inbreeding depression, potence ratio, heritability in both broad and narrow senses and expected genetic advance upon selection. This estimation will enable the breeder to foresee the reliability of selection for yield and its components, in his efforts to produce high yielding varieties. Several workers studied the genetic these characters. El – Harony (1988) found over – dominance for days to first flower, height of first fruiting node, seed cotton yield, number of bolls, boll weight and seed index, while partial dominance was obtained for lint percentage. The dominance gene effects as well as same types of epistatis effects played a major role in the inheritance of days to first flower and height of the first fruiting node. The additive and epistatis effects played the major role in the inheritance of seed cotton yield per plant, seed index, boll weight, number of bolls per plant and lint percentage. Patile *et al.* (1992) in their study found that the non- additive gene action was predominant for the inheritance of seed index, whereas the additive gene effect was observed for lint percentage. Abo – Arab *et al.* (1994) observed that both dominance and additive genetic variances were highly significant for seed index and lint percentage and the first character showed over–dominance. El-Disouqi *et al.* (2000), observed that over – dominance appeared to control most studied traits in F1 hybrids and F2 generations and the remaining traits ranged from partial to complete dominance. Significant positive inbreeding depression for boll weight and seed index. The additive gene effects were significant and positive for seed cotton yield per plant, lint yield per plant and boll weight. Mohamed *et al.* (2001) reported significant positive additive gene effects for seed cotton yield per plant, lint yield per plant, boll weight, lint percentage and number of bolls per plant, but it was significantly negative for position of first fruiting node and date of first flower. Significant additive x additive gene action was detected for boll weight, lint percentage and number of bolls per plant. Dominance x dominance type of epistasis was significant for lint percentage, seed index and date of first flower. Eissa (2004) reported that significant dominance gene effects were found for position of first node, boll weight, seed index and fiber strength. Additive x additive effect were significant for position of first node, seed index and lint percentage, but significant dominance x dominance types of epstasis were detected for position of first node, seed index and fiber strength. El-Adly (2004) showed that the inbreeding depression was highly significant positive for Pressly index and 2.5 % span length, while it was negatively significant for lint cotton yield, 50 % span length and seed cotton yield. Additive x additive type of epistasis values were significant or highly significant for all characters except days of first boll opening, seed cotton yield and pressly index, but dominance x dominance type of epistasis were negatively significant for seed cotton yield, lint cotton yield, micronaire reading, 2.5 % span length and number of bolls per plant. While dominance x dominance was positively significant for days to first flower, boll weight, 50% span length and lint percentage.

The present investigation aimed to study gene action effect, heritability and expected genetic advance upon selection for yield and its components in a cross between the two Egyptian cotton varieties, Giza 85 and Giza 90.

MATERIALS AND METHODS

This work was conducted in three growing seasons (2003-2005) at Giza Experimental Station, Agricultural Research Center. The material in this study consisted of the parents, F1, F2, BC1 and Bc2 populations of a cross between two long staple Egyptian cotton cultivars namely, Giza 85 that characterized by short compact plants and high yielding. (It was derived from crossing Giza 67 x CB58 and it is released as commercial cultivar since 1993 in South Delta) and Giza 90, It is characterized by high yield potential, high lint percentage and early maturity. (It was developed by the hybridization between Giza 83 and Dendera. It is used as commercial cultivars since 1999 in Upper Egypt).

In 2003 season the parental cultivars were crossed to produce F1 hybrid seeds. In 2004, the F1 was backcrossed to both parents. The parents were also crossed for more hybrid seeds. Self – pollination was also made for the parents to get selfed seeds. The F1 was selfed to obtain F2 seeds. In 2005, six populations, i.e. two parents (P1 and P2), F1, F2 and the two backcrosses (BC1 and BC2) were sown at four rows of each of the P1, P2 and F1, 24 rows for F2, and 20 rows for each the two back crosses. Each row was 7 meter in length, 65 cm. in width. Seeds were sown in hills spaced at 70 cm. After words, about four weeks from sowing the hills were thinned to a single plant per hill. All the agronomic practices were done according to the ordinary cotton culture.

The following measurements were taken on the individual plant bases for the six populations:

1. Seed cotton yield per plant (SCY/p): measured as the weight of SCY/ p in grams.
2. Lint cotton yield per plant (LCY/p): measured as the average weight of LCY/p in grams.
3. Boll weight (BW): measured as the average weight of five normal mature bolls picked at random from the middle zone of the plant.
4. Lint percentage (LP%): the ratio of lint weight to seed cotton weight expressed as percentage.
5. Seed index (SI): estimated as the mean weight of 100 seeds (in grams) from each plant.
6. Position of first fruiting node (PFN): node number at which the first fruiting branch is emerges on the main stem.
7. Days to first flower (DFF): number of days from sowing to the opening of the first flower.
8. Days to first opening boll (DFB): number of days from sowing to the opening of the first boll.
9. Number of harvested bolls per plant (B/P).
10. Earliness % (Ear. %) = (seed cotton yield for the first pick) / (total seed cotton yield for the 1^{st} pick + 2^{nd} pick).

The statistical method using generations means A, B and C scaling tests of Mather and Jinks (1971) were used to test the adequacy of additive – dominance model as well as, percentage of hetrosis, inbreeding depression, potence ratio, heritability in narrow and broad senses and genetic advance under selection were determined according to Allard (1960), Hayman (1958), Johanson *et al.* (1955), Miller *et al.* (1958) and Smith (1952).

RESULTS AND DISCUSSION

1 – Population means:

The means of the six populations and their standard errors for the studied characters are shown in Table 1. The results showed that Giza 90 (P2) surpassed Giza 85 (P1) for all studied traits. It could be concluded from the results that the F1 generation mean values had higher values than their corresponding mid – parental values as well as the highest parent for SCY/p, LCY/p, LP%, B/P and SI, but it was higher than the mid – parents for BW. The F1 hybrid was earlier than their corresponding mid – parents as well as the earliest parent for DFF and DFB, while it was earlier than mid – parent for PFN and Ear. %.

Table 1: Mean performance and standard error for parents, F1, F2, BC1 and BC2 populations for characters studied of the cross (G.85 x G.90).

Characters	P1 (Giza 85)	P2 (Giza 90)	F1	F2	BC1	BC2
SCY/p	30.78 ± 0.94	46.22 ± 1.63	50.90 ± 1.11	60.26 ± 1.82	40.41 ± 0.99	51.42 ± 1.00
LCY/p	11.69 ± 0.37	18.15 ± 0.68	20.16 ± 0.49	23.64 ± 0.75	15.13 ± 0.37	20.83 ± 0.49
BW	2.55 ± 0.04	2.83 ± 0.06	2.87 ± 0.05	2.91 ± 0.07	2.45 ± 0.04	2.81 ± 0.05
LP%	37.98 ± 0.15	39.24 ± 0.23	39.37 ± 0.23	38.23 ± 0.29	38.14 ± 0.17	39.60 ± 0.20
SI	9.48 ± 0.09	9.73 ± 0.18	10.24 ± 0.13	10.22 ± 0.17	9.88 ± 0.10	10.03 ± 0.11
PFN	7.57 ± 0.14	6.43 ± 0.14	6.85 ± 0.15	6.83 ± 0.18	6.94 ± 0.10	6.27 ± 0.10
DFF	73.39 ± 0.59	70.79 ± 1.09	67.27 ± 0.97	69.49 ± 1.18	70.06 ± 0.73	67.68 ± 0.73
DFB	126.5 ± 0.69	122.7 ± 1.30	120.8 ± 1.28	125.1 ± 1.66	125.3 ± 0.84	121.8 ± 0.65
B/P	12.06 ± 0.34	16.20 ± 0.76	17.98 ± 0.55	22.77 ± 0.83	16.83 ± 0.47	18.61 ± 0.47
Ear. %	80.2 ± 0.46	84.1 ± 1.14	83.6 ± 1.02	86.1 ± 1.38	79.9 ± 0.58	84.9 ± 0.87

From Table 1. The F2 means were higher than parental means; F1, BC1 and BC2 for most traits, but mean values of F2 generation were intermediate between the parental means for LP%, PFN and DFF. Therefore, selection may be effective in the improvement of these characters by recurrent selection in the following generations. Our results were in agreement with those of Abdel – Zaher *et al.* (2003), El-Adly (2004) and Mahmoud *et al.* (2004).

2- Heterosis, inbreeding depression and potence ratio:

Heterosis, inbreeding depression and potence ratio are presented in Table 2. High significant positive effects, relative to mid – parents, were detected for SCY/p, LCY/p, BW, LP%, SI and B/P. It was significant negative for DFF and DFB. Whereas, highly significant positive heterosis values relative to better parent, that is useful in cotton breeding, were obtained for all studied traits except, PFN, DFF and DFB, which were highly significant negative heterosis values. Similar results were obtained by El-Disouqi *et al.* (2000) and El-Adly (2004), they reported that the amount of heterosis depends upon the origin of parents involved in hybridization and the character under study.

Concerning inbreeding depression, the results illustrated significant inbreeding depression in F2 generation for SCY/p and DFB. Insignificant inbreeding depression was found for the other traits. These findings might suggest a sort of linkage or incomplete segregation. Similar results were reported by Mohamed *et al.* (2001), Abdel – Zaher *et al.* (2003) and El-Adly (2004).

Potence ratio (PR) values were exceeded unity for the traits; SCY/p, LCY/P, LP%, SI, DFF, DFB and B/P. This indicates that the heterotic effects could be attributed to over dominance and epistatic gene effects. Estimates of potence ratio for BW, PFN and Ear. % were less than unity, indicating partial dominance for these traits. Many investigators had reported similar conclusion among them, El-Disouqi *et al.* (2000), Mohamed *et al.* (2001) and El-Adly (2004).

Table 2: Heterosis, inbreeding depression (ID) and potence ratio (PR) for the studied traits of the cross G.85 x G.90.

Characters	Heterosis		ID	PR
	H.MP	H.BP		
SCY/p	32.218**	65.398**	-18.388*	1.606
LCY/p	35.106**	72.433**	-17.248	1.622
BW	5.608*	12.396**	-1.590	0.929
LP%	1.958**	3.656**	2.887	1.196
SI	6.560**	7.956**	0.170	5.073
PFN	-2.121	-9.474**	0.337	0.261
DFF	-6.680**	-2.337**	-3.299	3.697
DFB	-3.032*	-4.475**	-5.235*	2.008
B/P	27.254**	49.121**	-26.657	1.859
Ear. %	1.705	4.162**	-3.020	0.723

*, ** Significant and highly significant at 5% and 1% levels of probability, respectively.

The above results indicate that the main cause of heterotic effects was over dominance and epistatic gene effects for the most traits under study toward the better parent. Also, partial dominance effects were detected for BW, PFN and Ear. % toward the lower parent. Significant inbreeding depression for SCY/p and DFB suggested that the genes, which controlled these traits, were not completely segregated.

3- Scaling test:

The results of scaling test A, B and C are given in Table 3. It was worthy to mention that BW, B/P and Ear. % were significant deviated to A value, but SCY/p, LCY/p, PFN and B/P were significant deviated to B value.

Table 3: Scaling test for the characters studied in the six populations of Egyptian cotton cross, G.85 x G.90.

Characters	A	B	C
SCY/p	-0.867 ± 2.459	5.705 ± 2.808*	62.249 ± 7.832**
LCY/p	-1.603 ± 0.967	3.340 ± 1.296*	24.387 ± 3.244**
BW	-0.522 ± 0.111**	-0.132 ± 0.124	0.487 ± 0.312
LP%	-1.069 ± 0.441	0.587 ± 0.510	-3.034 ± 1.275*
SI	0.040 ± 0.250	0.103 ± 0.305	1.191 ± 0.767
PFN	-0.536 ± 0.283	-0.732 ± 0.276*	-0.389 ± 0.802
DFF	-0.542 ± 1.844	-2.694 ± 2.136	-0.754 ± 5.268
DFB	3.386 ± 2.219	-0.017 ± 2.249	17.743 ± 7.258*
B/P	3.626 ± 1.132**	3.039 ± 1.320*	26.672 ± 3.600**
Ear. %	-4.098 ± 1.613*	2.211 ± 2.322	12.698 ± 6.025*

*, ** Significant and highly significant at 5% and 1% levels of probability, respectively.

While BW, SI, PFN and DFF were significant to C value. Significance indicates the presence of non-allelic interaction. While insignificant scaling test suggests that the additive and dominance effects are important for these traits. These results were supported by Okasha *et al.* (1998), El-Disouqi *et al.* (2000), Eissa (2004) and El-Adly (2004).

4- Gene effects:

The data in Table 4 revealed that the mean effect of F2 performance (m) was highly significant for all studied characters. Initially, it is clear that these characters were quantitatively inherited. Also, the additive effect (d) were significant and positive for PFN, DFF and DFB, but it was significant and negative for the other characters. While, it was insignificant and negative for SI only. On the other hand, dominance effect values (h) were significant and negative for most traits except, SI, PFN and DFF. The additive component (d) were large relative to the non-additive variance (h) for (PFN) only.

It could be concluded that the improvement of position of first fruiting node PFN could be achieved in early segregating generations, but other characters needs recurrent selection through later generations. In this respect, Merdith and Bridge (1972) and El-Adly (2004), found that the greater part of genetic variance was additive some characters under study.

Generally, the dominance gene effects (h) were relatively greater in magnitude for most studied characters compared with the additive effect (d). These results indicate that improvement of these characters could be achieved through recurrent selection procedure. Jain and Dharam (1980) noticed that dominance variance was the major contribution for yield and number of bolls, while additive gene action was important for seed number, boll weight and lint index.

The additive x additive type of epistasis (i) was significant and negative for all traits except, SI, PFN and DFF that showed insignificant and negative values of epistatic gene effects. But, it was positively significant for LP% only.

The epistatic gene action of the type additive x dominance (j) values was significant and negative for LCY/p, BW, LP% and Ear. %, while, the other traits were insignificant. Regarding to the interaction, dominance x dominance (l), the values were positive significant for SCY/p, LCY/p, BW, B/P and Ear. %.

Table 4: Estimates of gene action for yield and its components in the intraspecific cotton cross, (G.85 x G.90).

Characters	M	d	h	i	j	l
SCY/p	60.264**	-11.009**	-45.007**	-57.411**	-6.572	52.573**
LCY/p	23.639**	-5.702**	-17.411**	-22.650**	-4.944**	20.913**
BW	2.913**	-0.359**	-0.988**	-1.141**	-0.390*	1.794**
LP%	38.230**	-1.461**	3.308*	2.552*	-1.657**	-2.070
SI	10.218**	-0.156	-0.417	-1.047	-0.063	0.904
PFN	6.825**	0.666**	-1.026	-0.878	0.196	2.145
DFF	69.492**	2.379*	-7.298	-2.483	2.153	5.720
DFB	127.143**	3.584**	-18.151*	-14.373*	3.404	11.004
B/P	22.771**	-1.779**	-16.356**	-20.207**	0.586	13.542**
Ear. %	66.094**	-5.093**	-13.383*	-14.784*	-6.309*	16.671*

*, ** Significant and highly significant at 5% and 1% levels of probability, respectively.

From the above results, it could be concluded that the dominance x dominance type of epistasis was greater in magnitude than those of the other genetic components for the most studied traits, these results, generally suggest the importance of non-additive gene effects in the heritance of most of these traits. In this respect, El-Disouqi *et al.* (2000), Mohamed *et al.* (2001) and Mahmoud *et al.* (2004) reported high magnitude of epistatic components rather than the other genetic components for most studied characters.

5- Hertability and genetic advance estimates:

High broad senses heritability estimates were found for SCY/p, LCY/p, DFB, B/P and Ear. %, exceeding 50 % (Table 5). These indicate that selection for high values of these traits on individual plant basis would be possible. While the other traits showed relatively moderate broad sense heritability estimates (from 30% to 50%).

From the above results, it could be concluded that selection on the basis of phenotype could be highly effective for these traits. These finding are in general accordance with those obtained by Mohamed *et al.* (2001) and El-Adly (2004).

Moderate narrow sense heritability estimates were calculated for LCY/p, BW, LP%, SI, DFF and B/P, which ranged from 30% to 50%. On the contrary, low heritability in narrow sense values were obtained for SCY/p, PFN, DFB and Ear. %. These results are in harmony with those obtained by Verhalen *et al.* (1971) and El-Adly (2004).

The expected genetic advance values from selecting the desired 5% of population in F2 plants (Table 5) ranged from 4.38 % for DFB to 18.70 % for B/P. These results of expected genetic advance for SCY/p, LCY/p, BW, PFN, DFF and B/P were high for the expected genetic advance values from selecting, indicating that the improvement of these characters is highly effective through selection. Mohamed *et al.* (2001) and El-Adly (2004) found that the genetic advance upon selection was high for boll weight and number of bolls per plant.

It could be concluded that the improvement of position of first fruiting node could be achieved in early segregating generations, but the improvement of the other characters needs recurrent selection through later generations.

Table 5: Heritability estimates in both broad (H^2b %) and narrow (H^2n %) and expected genetic advanced upon selection (G.S%) for characters studied of the cross (G.85 x G.90).

Characters	Heritability		(G.S%
	(H^2b %)	(H^2n %)	
SCY/p	51.75	29.95	14.77
LCY/p	50.19	34.25	17.73
BW	44.39	40.93	16.28
LP%	49.58	41.03	5.08
SI	39.76	34.94	9.74
PFN	39.58	29.44	12.72
DFF	41.04	40.48	11.28
DFB	53.55	20.55	4.38
B/P	52.16	31.32	18.70
Ear. %	55.35	28.64	7.53

*, ** Significant and highly significant at 5% and 1% levels of probability, respectively.

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دراسات وراثية للمحصول ومكوناته لهجين صنفي من القطن المصري (جيزة ٨٥ × جيزة ٩٠)

إبراهيم سيد محمد حسن

معهد بحوث القطن – مركز البحوث الزراعية بالجيزة

أجرى هذا البحث بمزرعة مركز البحوث الزراعية بالجيزة خلال ثلاثة مواسم (٢٠٠٣ – ٢٠٠٥) بهدف تقدير الثوابت الوراثية مثل قوة الهجين ودرجة السيادة ومكونات التباين الوراثي ودرجة التوريث وقيم التحسين المتوقع من الانتخاب لبعض صفات المحصول ومكوناته وبعض صفات التبكير في هجين صنفي من القطن المصري (جيزة ٨٥ × جيزة ٩٠) وكانت أهم النتائج المتحصل عليها هي :-

- تفوقت نتائج متوسطات الجيل الأول بالمقارنة بالأب الأفضل في كل الصفات المدروسة عدا صفتي وزن اللوزة ، وعقدة أول فرع ثمري.
- أثبتت النتائج أن قوة الهجين منسوبة إلى أحسن الأبوين وكذلك إلى متوسط الأبوين كانت عالية المعنوية وموجبة لصفات محصول القطن الزهر والشعر / نبات ، ووزن اللوزة ، معدل الحليج ، معامل البذرة ، عدد اللوز / نبات . بينما كانت سالبة وعالية المعنوية لصفتي تاريخ تفتح أول زهرة ، تاريخ تفتح أول لوزة – أما صفتي عقدة أول فرع ثمري ، نسبة التبكير % فقد أعطت قيمة سالبة وعالية المعنوية لقوة الهجين منسوبة إلى الأب الأفضل.
- كانت قيم الانخفاض الراجع إلى التربية الداخلية معنوية وسالبة لصفتي محصول القطن الزهر / نبات ، تاريخ تفتح أول لوزة.
- أوضحت النتائج أن معظم الصفات المدروسة أظهرت سيادة فائقة عدا صفات وزن اللوزة ، وعقدة أول فرع ثمري ، ونسبة التبكير % فقد أظهرت سيادة جزئية.
- كان الفعل الجينى المضيف معنوي وموجب لصفات عقدة أول فرع ثمري ، وتاريخ ظهور أول زهرة وتاريخ تفتح أول لوزة – بينما كان معنويا وسالبا لجميع الصفات الأخرى عدا صفة معامل البذرة حيث كان الفعل الجينى المضيف لهذه الصفة غير معنوي – وكان الفعل السيادى للجين موجب ومعنوي لصفة معدل الحليج فقط.
- أظهرت نتائج مكونات التباين الوراثي إلى أن التأثير الجينى غير المضيف كان أكبر من التأثير المضيف في توارث معظم الصفات محل الدراسة.
- أوضحت النتائج أن تأثير التفوق الراجع إلي الفعل الجينى المضيف × المضيف كان ذو قيم معنوية وعالية لجميع الصفات تحت الدراسة عدا صفات معامل البذرة ، وعقدة أول فرع ثمري وتاريخ تفتح أول زهرة.
- كانت قيم درجة التوريث بالمعنى الواسع عالية لصفات محصول القطن الزهر والشعر / نبات ، وتاريخ تفتح أول لوزة ، وعدد اللوز / نبات ، ونسبة التبكير % – بينما كانت متوسطة لباقي الصفات المدروسة. وكانت درجة التوريث بالمفهوم الضيق متوسطة لمعظم الصفات محل الدراسة.
- أظهر التحسين المتوقع من الانتخاب قيم عالية لصفة عدد اللوز/ نبات (١٨,٧ %) ، محصول القطن الشعر/ نبات (١٧,٧٣ %) ، وزن اللوزة (١٦,٢٨ %) ، ومحصول القطن الزهر / نبات (١٤,٧٧ %).
- من هذه النتائج يمكن استنتاج أنه يمكن تحسين صفة موقع عقدة أول فرع ثمري من الأجيال الانعزالية المبكرة ، بينما تحتاج باقي الصفات إلى انتخاب مكثف لعدة أجيال لتحسين تلك الصفات.