Egypt. J. Plant Breed. 14(1): 43 – 52 (2010)

GENETIC BEHAVIOR OF YIELD COMPONENTS AND FIBER PROPERTIES IN TWO EGYPTIAN COTTON CROSSES

G.H. Abd El-Zaher and M.A. Al-Ameer

Cotton Research Institute, Agric. Res. Center, Giza

ABSTRACT

This study was carried out during three successive seasons, 2006, 2007 and 2008 at the field trial experiments at Experimental of Cotton Research Institute at El-Minia Governorate. To study the genetic behavior of yield components and fiber properties in two crosses i.e. (Giza 70 × Giza 80) and (Giza 70 × Giza 90). The results showed significant positive heterosis relative to mid-parent for seed cotton yield, lint yield and boll weight in the two crosses. Whereas, significant negative heterosis were obtained for lint percentage, seed index, lint index, micronaire reading and fiber strength in the two crosses. Also, heterosis relative to the better parent was noticed they were and positive only for boll weight in cross 1 and micronaire reading in cross 2. While significant negative values were observed for lint percentage, seed index, lint index and fiber strength in the two crosses and seed cotton yield and lint yield in cross 1. Concerning inbreeding depression the results showed that significant positive values for boll weight in both crosses, fiber length in cross 1 and lint yield and micronaire reading in cross 2. Wherever, significant negative inbreeding gain was achieved for seed index, lint index and micronaire reading in cross 1 and lint percentage and fiber strength in cross 2. Over-dominance appeared to be controlling lint percentage, seed index and lint index in both crosses, boll weight and micronaire reading in cross 1 and seed cotton yield and lint yield in cross 2, and the remaining traits indicating partial dominance. Besides, the results showed medium values of heritability in broad sense for all studied traits in both crosses. And, the expected genetic advances were relatively high for all studied traits except lint percentage trait in both crosses.

Key words: ***Heterosis, Inbreeding depression, Potence ratio, Heritability, Expected genetic Advance, Genotypic and phenotypic variance, Intra-specific, Gossypium barbadense, Yield, yield components and fiber properties.***

INTRODUCTION

The goal of most plant breeding programs is to increase yielding capacity and improving fiber properties of commercial cotton cultivars.

Yield is known to be a complex trait highly affected by environment conditions. Thus, direct selection for yield is not expected to be effective. Therefore, the breeder avoids selection for yield and prefers to select for its components individually. The value of genotype is not an inheriting trait absolute quality of the genotype, but depends on the range of environments over which it has been tested. So, the estimates of genotypic variances would depend on the interaction with the environments under which the material will be tested. Besides, any cross program among selected genotypes needs knowledge concerning multiple factors, heterosis, inbreeding depression and potence ratio. El-Kilany and El-Mazar (1985) pointed out that negative and highly significant heterotic effects were showed for boll weight and lint percentage, whereas lint index showed positive heterosis. These heterotic effects were accompanied by negative inbreeding depression in F_2. Additive, dominance and espistatic gene effects were involved in the inheritance of these traits. Hemida (1996) obtained heterosis over for mid-parents and the better-parents. He also found insignificant inbreeding depression values for seed cotton yield/plant and lint yield/plant. Abo-Arab *et a*l (1997) observed high heritability and predicted genetic gain estimated for boll weight, seed cotton yield, lint yield per plant and seed index. El-Disouqi *et al* (2000) showed that the over-dominance appeared to be controlling most studied traits in F_1 hybrids and F_2 generations overall crosses and the remaining traits ranged from partial to complete dominance. They also showed Significant and positive inbreeding depression in F_2 for boll weight, seed index and lint index in all crosses.

The purpose of this investigation was to study the genetic behavior of yield, yield components and fiber properties in two Egyptian cotton crosses.

MATERIALS AND METHODS

This investigation was conducted in three successive growing seasons (2006-2008) and was carried out at the field trial experiments at Experimental of Cotton Research Institute at El-Minia Governorate. Three cultivars of cotton belong to (*Gossypium barbadense* L.), namely Giza 70, Giza 80 and Giza 90 were used in the present work.

In 2006 growing season, the parental cultivars were crossed as follows, cross 1 (Giza 70 × Giza 80) and cross 2 (Giza 70 × Giza 90) to produce the F_1 hybrid seeds.

In 2007 season, seeds of parents and (F_1' s) were sown and the F_1 hybrid plants from each cross were self-pollinated to produce F_2 populations' seeds.

For studying the genetic behavior of yield, yield components and fiber properties, seeds of the four populations, P_1, P_2, F_1 and F_2 of each cross were sown in the season 2008. Each non-segregating growing generation (P_1, P_2 and F_1) consisted of three rows, and F_2 contained 15 rows. Each row was 4.5 m long, 65 cm apart and comprised 15 hills each of one plant. Cultural practices were applied as usually recommended for ordinary cotton fields. At the end season 2008, 30 and 150 guarded plants from the non-segregating and segregating generations, respectively, of the two crosses were separately harvested and ginned. The data were recorded on a single plant for the following traits: seed cotton yield/plant in grams (SCY/p), lint yield/plant in grams (LY/p), boll weight in grams (BW), lint percentage (LP), seed index in grams (SI), lint index in grams (LI), Micronaire reading (MIC), fiber length (FL) and fiber strength (FS). The fiber properties were measured in the laboratories of The Cotton Fiber Research Section, Cotton Research Institute according to A.S.T.M. (1967).

Data analysis followed the procedures and methods outlined by Mather and Jinks (1971) and Falconer (1983) for the computation of heterosis, potence ratio, inbreeding depression, heritability estimates, phenotypic and genotypic coefficients of variation and genetic advance at 5 % selection intensity.

Heterosis was determined as the percent of deviation of F_1 hybrids from its mid-parent (MP) or its better-parent (BP) values as follows:

$$\text{Heterosis from the mid-parent} = \frac{F_1 - MP}{MP} \times 100$$

$$\text{Heterosis from the better-parent} = \frac{F_1 - BP}{BP} \times 100$$

Potence ratio was estimated as follow:

$$\text{Potence ratio in } F_1 = \frac{F_1 - MP}{1/2\,(P_1 - P_2)}$$

Inbreeding depression was calculated from the formula:

$$\text{Inbreeding depression} = \frac{F_1 - F_2}{F_1} \times 100$$

Heritability estimates h_b^2 (in broad sense) was computed as the ratio between the genotypic variance to the phenotypic variance by the following formula:

$$h_b^2\,\% = \frac{\dot{O}\,G}{\dot{O}\,P} \times 100$$

$\dot{O}\,G = V\,F_2 - V\,E$

$V\,E = V\,P_1 + V\,P_2 + V\,F_1 / 3$

h_b^2 = the broad sense heritability.

$\dot{O}\,P$ = the phenotypic variance (variance of F_2).

$\dot{O}\,G$ = the genotypic variance.

The predicted genetic advance under selection (G.S. %) was computed according to Johanson *et al* (1955).

$$\text{Predicted genetic gain (G.S.)} = K.\sqrt{\dot{o}\,P}\;.\;h^2 b$$

Where:

K = the standardized selection differential (at 5 % selection intensity equal 2.06).

Also, this expected gain represented as a percentage of F_2 mean (G.S. %) according to Miller *et al* (1958).

G.S. % = G. S. /F_2 ×100

Where:

G.S. % = Expected genetic advance.

F_2 = Mean of F_2 population.

RESULTS AND DISCUSSION

The performances of parents, F_1, and F_2 for all studied traits are illustrated in Table (1). The data showed that the observed means in both generations differed than the calculated arithmetic means in most traits. The results cleared that the P_2 in cross 1 (Giza 80) was the highest yielding parent for seed cotton yield, lint yield and lint percentage. The P_1 (Giza 70) in both crosses exhibited the best mean performance for micronaire reading and fiber length. Moreover, cross 1 (Giza 70 × Giza 80), in F_1 and F_2 generations showed the best values for most of the studied traits.

Data in Table (2) illustrated heterosis, inbreeding depression and potence ratio for yield, yield components and fiber properties in the two crosses. The values of heterosis versus the mid-parent and better parent were calculated and the results showed significant positive heterosis relative to mid-parent for seed cotton yield, lint yield and boll weight in the two crosses. Whereas, significant negative heterosis relative to mid-parent was found for lint percentage, seed index, lint index, micronaire reading and fiber strength in the two crosses.

Also, heterosis relative to better parent revealed significant positive heterosis for boll weight in the first cross and micronaire reading in the second cross, while significant negative values were observed for lint percentage, seed index, lint index and fiber strength in the two crosses and seed cotton yield and lint yield in the first cross. El-Okkia *et al* (1989), found that the heterosis relative to mid-parent was significant and positive for seed cotton yield /plant, lint yield /plant and lint index and significant negative for seed index and lint percentage, while significant negative heterosis relative to better parent was recorded for lint yield, lint percentage and lint index. El-Disouqi *et al* (2000) showed significant negative heterosis relative to better parent for lint percentage and lint index. Significant positive heterosis relative to better parent, indicating that the increasing alleles were more frequent than decreasing (minis) ones, and significant negative heterosis, indicating that decreasing alleles were more frequent.

Table 1. Mean performances of parents, F_1 and F_2 generations for yield, yield components and fiber properties of the two crosses.

Traits / Cross		P_1	P_2	F_1		F_2	
				Actual	Arith.	Actual	Arith.
SCY/p (gm)	C1	38.13	60.04	52.74	49.09	52.55	50.91
	C2	38.13	45.08	47.79	41.61	41.90	44.70
LY/p (gm)	C1	14.74	24.01	20.29	19.38	20.50	19.83
	C2	14.74	17.05	17.33	15.90	15.93	16.61
BW (gm)	C1	2.52	2.99	3.11	2.76	2.72	2.93
	C2	2.52	3.06	2.92	2.79	2.71	2.86
L P (%)	C1	38.67	39.99	38.46	39.33	39.00	38.90
	C2	38.67	37.76	36.25	38.22	38.02	37.23
S I (gm)	C1	10.75	10.71	10.18	10.73	10.32	10.46
	C2	10.75	10.99	10.53	10.87	10.40	10.70
L I (gm)	C1	6.78	7.14	6.36	6.96	6.61	6.66
	C2	6.78	6.68	5.99	6.73	6.38	6.36
MIC	C1	3.88	4.28	3.47	4.08	3.96	3.78
	C2	3.88	4.47	3.97	4.18	3.93	4.07
F L	C1	35.64	32.53	35.39	34.09	33.80	34.74
	C2	35.64	31.47	33.89	33.56	34.07	33.72
F S	C1	10.26	9.77	9.96	10.02	9.91	9.99
	C2	10.26	9.53	9.62	9.90	10.11	9.76

Concerning inbreeding depression the results showed significant positive inbreeding depression for boll weight in the two crosses, fiber length in cross 1 and lint yield and micronaire reading in cross 2, indicating the accumulation of additive gene effects which in turn increase the mean expression of these characters, while it showed significant negative inbreeding gain for seed index, lint index and micronaire reading in cross 1 and lint percentage and fiber strength in cross 2.This finding suggested that the genes which control these characters were not completely segregated. Gomaa and Shaheen (1995a), found significant positive inbreeding depression for seed cotton yield /plant and seed index, while it was significant negative for lint percentage.

Potence ratio was more than unity for lint percentage, seed index and lint index in both crosses, boll weight and micronaire reading in the first cross and seed cotton yield and lint yield in the second cross, indicating over dominance which might have been caused by repulsion linkage. In the same time, the remaining characters exhibited positive or negative values of potence ratio, less than unity, indicating partial dominance (Abd El-Zaher *et al* 2003).

Table (3) shows the genotypic and phenotypic variance, heritability estimates in broad sense, and expected genetic advance under selection for

Table 2. Heterosis, potence ratio and inbreeding depression for yield, yield components and fiber properties of the two crosses.

Crosses	Traits	S.C.Y.	L.Y.	B.W.	L. P.	S. I.	L. I.	MIC.	F. L.	F. S.
Cross 1	M.P.	7.44*	4.70**	12.68**	-2.21*	-5.13**	-8.62**	-14.95**	3.81	-0.60*
	B.P.	-12.16**	-15.49**	4.01**	-3.83**	-5.30**	-10.92**	-10.57**	-0.70	-2.92**
	P	0.33	0.20	1.49	-1.32	-27.50	-3.33	-3.05	0.84	-0.24
	I.D.	0.36	-1.03	12.54**	-1.40	-1.38**	-3.93**	-14.12**	4.49**	0.50
Cross 2	M.P.	14.85**	8.99**	4.66**	-5.15**	-3.13**	-11.00**	-5.02**	0.98	-2.83**
	B.P.	6.01	1.64	-4.58**	-6.26**	-4.19**	-11.65**	2.32**	-4.91**	-6.24**
	P	1.78	1.24	0.48	-4.33	-2.83	-14.8	-0.71	0.16	-0.77
	I.D.	12.32	8.08**	7.19**	-4.88**	1.23	-6.51**	1.01**	-0.53	-5.09**

MP = Heterosis for mid-parent B. P. = Heterosis for better-parent P = Potense ratio I.D. = Inbreeding depression

Table 3. Genotypic (Ȯ G) and phenotypic (Ȯ P) variance, heritability (h_b^2) genotypic (G.C.V. %) and phenotypic (P.C.V. %) coefficients of variation and predicted genetic gain (G.S.) for yield, yield components and fiber properties of the two crosses.

Cross	Traits	S.C.Y.	L.Y.	B.W.	L. P.	S. I.	L. I.	MIC.	F. L.	F. S.
1 (G.70 × G. 80)	S^2g	88.167	13.812	0.124	0.781	0.118	0.096	0.101	1.122	0.183
	S^2p	98.534	15.410	0.166	1.307	0.188	0.170	0.128	1.755	0.232
	h^2 %	89.48	89.63	74.70	59.76	62.77	56.47	78.91	63.93	78.88
	G.C.V. %	17.87	18.13	12.95	2.27	3.33	4.69	8.03	3.13	4.32
	P.C.V. %	18.89	19.15	14.98	2.93	4.20	6.24	9.03	3.92	2.34
	G.S.	18.297	7.248	0.627	1.407	0.561	0.533	0.582	1.745	0.783
	G.S. %	34.818	35.356	23.051	3.608	5.436	8.064	14.697	5.163	7.901
2 (G.70 × G. 90)	S^2g	14.029	2.005	0.036	1.114	0.167	0.159	0.040	2.026	0.116
	S^2p	25.101	3.623	0.082	1.602	0.269	0.229	0.074	2.606	0.220
	h^2 %	55.89	55.34	43.90	69.54	62.08	69.43	54.05	77.74	52.73
	G.C.V. %	8.94	8.89	7.00	2.78	3.93	6.52	5.09	4.18	3.37
	P.C.V. %	11.96	11.95	10.57	3.33	4.99	7.50	6.92	4.74	4.64
	G.S.	5.768	2.170	0.259	1.813	0.663	0.684	0.303	2.585	0.509
	G.S. %	13.766	13.622	9.557	4.769	6.375	10.721	7.710	7.450	5.035

yield, yield components and fiber properties in the two crosses. Medium to high values of heritability were detected for all studied traits in both crosses, which could be due to dominance and espistatic gene effects. This indication means that the selection for high expression of them on phenotype basis could be effective. These results were in agreement with those obtained by Eissa (1996), El-Adly (1996), Abd El-Hadi *et al* (2005), Abd El-Bary *et al* (2008) and Abd El-Zaher *et al* (2009).

The estimates of genotypic and phenotypic coefficients of variation appeared to be higher for seed cotton yield, lint yield, boll weight and micronaire reading in both crosses than the other traits. However, the remaining studied traits exhibited small differences between genotypic and phenotypic coefficients of variation, revealing that environmental effects were not of great importance on these traits. These results were assured by heritability values in broad sense.

The expected genetic advance values from selection of the desired 5 % of F_2 population are presented in (Table 3). These data showed that the expected genetic gains for all studied traits in both crosses were relatively high except lint percentage trait. Similar results were obtained by El-Adly (1996) and Abo-Arab *et al* (1997) who found that the predicted genetic gains were relatively high for boll weight, seed cotton /plant, lint yield /plant and seed index.

REFERENCES

Abd El-Bary, A.M.R., A.M. Soliman and H.H. Adly (2008). Diallel analysis for yield components and fiber traits in *Gossypium barbadense* L. J. Agric. Sci. Mansoura Univ., 33 (2): 1163-1172.

Abd El-Hadi, A.H., Z.M. El-Diasty, M.S. Hamada, M.A. Raaft and W.M.B.Yehia (2005). Genetic behavior of yield and yield components traits in some intraspecific cotton crosses. J. Agric.Res. (Fac. Of Agric. Saba Basha) Vol. 10 (1): 83-102.

Abd El-Zaher, G.H., H.S. Khalefa and Hanan M. Abd El-Gelil (2009). Diallel analysis in some intraspecific cotton crosses for yield components and fiber traits. J. Agric. Sci. Mansoura Univ., 34 (4): 2565-2575.

Abd El-Zaher, G.H., T.M. El-Ameen, A.F. Lasheen and S.Sh. Abduallah (2003). Genetic analysis of yield and its components in some intraspecific cotton crosses. Proced. Third Pl. Breed. Conf. April 26, 2003 (Giza), Egypt. J. Plant Breed. 7 (1): 23-40, Special Issue.

Abo-Arab, A.R.A., A.F. Lasheen and Z.F. Abo-Sen (1997). Genetical analysis of yield and its components in Egyptian cotton. J. Agric. Sci. Mansoura Univ., 22 (11): 3675- 3681.

A.S.T.M. (1967). American Society for Testing Materials. Part 25, Designation, D-1447-59, D-1447-60T and D-1447-67, U.S.A.

Eissa, A.E.M. (1996). Genetical studies on earliness and yield components of some cotton crosses. M. Sc. Thesis, Fac. Agric., Minia University., Egypt.

El-Adly, H.H. (1996). Studies on earliness , yield components and lint properties in two crosses of cotton. M. Sc. Thesis, Fac. Agric., Alex. University, Egypt.

El-Disouqi, A.E., Z.F. Abo-Sen and A.R. Abo-Arab (2000). Genetic behavior of yield and its components in Egyptian cotton. J. Agric. Sci. Mansoura Univ., 25 (7): 3831-3840.

El-Kilany, M.A. and M.F. Al-Mazar (1985). Genetic studies on some agronomic characters in cotton. Agric. Res. Rev., 63 (6): 15-25.

El-Okkia, A.F.H., H.B. Abou-Tour and M.M. El-Shishtawy (1989). Genetic analysis of yield and other important characters in Egyptian cotton (*Gossypium barbadense* L.). Minufiya J. Agric. Res. 14 (2): 855-874.

Falconer, D.S. (1983). Introduction to Quantitative Genetics. 2 nd. ed. The Ronald Press Co., New York.

Gomaa, M.A.M. and A.M.A. Shaheen (1995). Heterosis, inbreeding depression, heritability and type of gene action in two intra-barbadense cotton crosses. Annals Agric. Sci. Ain-Shams Univ. Cairo, 40 (1): 165-176.

Hemida, G.M.K.A. (1996). Environmental effects on general and specific combining ability in Egyptian cotton. Ph. D. Thesis, Fac. Agric., Moshtohor, Zagazig Univ., Egypt.

Johanson, H.W., H.F. Robinson and R.E. Comstock (1955). Estimates of genetic and environmental variability in soybeans. Agron. J. 47: 314-318.

Mather, K. and J.L. Jinks (1971). Biometrical Genetics. (2^{nd} ed.), Chapman and Hall, London.

Miller, P.A., D.S. Williams, H.F. Robinson and R.C. Comstock (1958). Estimates of genotypic and environmental variances and covariance in Upland cotton and their implications in selection. Agron. J. 50: 126-131.

السلوك الوراثى لمكونات المحصول وصفات التيلة لهجينين من القطن المصرى

جمال حسين عبد الظاهر – محمد عبد المولى الامير

معهد بحوث القطن – مركز البحوث الزراعية – وزارة الزراعة

أجريت هذه الدراسة خلال ثلاثة مواسم متتالية ٢٠٠٦، ٢٠٠٧، ٢٠٠٨ فى تجارب معهد بحوث القطن والمقامه بمحافظة المنيا ، وتهدف الدراسة الى دراسة السلوك الوراثى للمحصول ومكوناته وجودة التيلة فى هجينين من القطن المصرى وهما (جيزة ٧٠ × جيزة ٨٠) و (جيزة ٧٠ × جيزة ٩٠).

وكانت أهم النتائج المتحصل عليها كما يلى :-

١. كانت قوة الهجين مقارنة بمتوسط الأبوين (M.P) ذات تأثير معنوى موجب بالنسبة لصفات محصول القطن الزهر ، محصول القطن الشعر ، ووزن اللوزة لكلا الهجينين ، بينما وجد تأثير

معنوى سالب لصفات تصافى الحليج ، معامل البذرة ، معامل الشعر ، قراءة الميكرونير ، ومتانة التيلة لكلا الهجينين .

٢. كانت قوة الهجين ذات تأثير معنوى موجب مقارنة بالأب الأفضل (B.P) بالنسبة لصفة وزن اللوزة للهجين الأول ، وصفة قراءة الميكرونير للهجين الثانى ، بينما وجد تأثير معنوى سالب لصفات تصافى الحليج ، معامل البذرة ، معامل الشعر ، ومتانة التيلة لكلا الهجينين ، ولصفات محصول القطن الزهر ، محصول القطن الشعر للهجين الأول .

٣. وفيما يتعلق بتأثير التربية الداخلية ، كان الأنخفاض الراجع الى التربية الداخلية معنوى موجب لصفة وزن اللوزة لكلا الهجينين ، ولصفة طول التيلة للهجين الأول ، ولصفتى محصول الشعر وقراءة الميكرونير للهجين الثانى ، بينما كانت القيم المتحصل عليها سالبه لصفات معامل البذرة ، معامل الشعر ، وقراءة الميكرونير للهجين الأول ، وصفات تصافى الحليج ، معامل الشعر ، ومتانة التيلة للهجين الثانى .

٤. أظهرت النتائج وجود سيادة فائقة لصفات تصافى الجليج ، معامل البذرة ، ومعامل الشعر لكلا الهجينين ، وصفتى وزن اللوزة ، وقراءة الميكرونير للهجين الأول ومحصول القطن الزهر ومحصول الشعرللهجين الثانى ، بينما كانت درجة السيادة لباقى الصفات فى كلا الهجينين سيادة جزئية.

٥. أظهرت النتائج قيم متوسطة لكفاءة التوريث الى عالية فى المفهوم العام لكل الصفات لكلا الهجينين، كما كانت قيم التحسين الوراثى المتوقع بالأنتخاب مرتفعة لكل الصفات لكلا الهجينين ماعدا صفة تصافى الحليج.