J. Agric. Sci. Mansoura Univ., 28 (2): 811 - 818, 2003

GENETIC BEHAVIOR OF SOME ECONOMIC CHARACTERS IN A HYBRID BETWEEN TWO GENOTYPES OF EXTRA-LONG COTTON

Allam, M. A. M.
Cotton Research Institute, Agricultural Research Center, Giza.

ABSTRACT

This experiment was conducted at the Experimental Farm, Sakha Agricultural Research Station during the successive growing seasons of 1998, 1999 and 2000. Two extra long strains namely (Giza 84 X F. 108) and [Giza 45 X (Giza 45 X Giza 84)]. The genetical parameters of some economic characters were computed. The potence ratio estimates indicated over dominance for seed cotton and lint yield per plant, boll weight, seed index and node number of the first fruiting branch. While, lint percent, lint index and days to first flower showed partial potence ratios.

Highly significant positive heterotic effect relative to mid-parent and better-parent was computed for seed cotton yield and lint yield while significant negative heterotic effect relative mid-parent and better-parent was computed for lint percentage and lint index.

The inbreeding depression effect was highly significant for seed cotton yield, lint yield, and significant negative for lint percentage and lint index.

Highly significant values of additive and dominance were found for seed and lint cotton yield with greater magnitude for dominance than additive effect. Highly significant positive value of the epistatic effect (additive X additive) was found for seed cotton yield and lint yield per plant. A significant negative value of epistatic effect (additive X dominance) was found for seed cotton yield. Meanwhile, highly significant negative values of epistatic effect (dominance X dominance) was showed for seed cotton yield and lint yield. Moderate hertablities was calculated for seed cotton yield and lint yield. Low values of hertablities for other traits.

INTRODUCTION

The goal of plant breeders is to increase yielding capacity of cultivated crops. The knowledge of gene action and gene interaction involved in the inheritance of quantitative characters help the plant breeders in their evaluation of various selection and breeding procedures. Several studies were employed to a certain heterosis, inbreeding depression and type of gene action in cotton and their implication in cotton breeding programs.

Different results were obtained by El-Gohary *et al.* (1981), El-Helw (1981 and 2002), Sallame *et al.* (1985), Al-Enani (1986), Al-Hashash (1987), Ismail (1988), Abo Arabe *et al.* (1994) and Abdel-Gelil (2001).

The present study was planned to determine the type of gene action and to compute some genetic estimates in the extra-long cotton cross.

MATERIALS AND METHODS

A cross between the two lines (G. 84 X F. 108) (P_1) and [G 45 X (G. 45 X G. 84)] P_2 had been carried out in 1998 season.

In 1999 season, the hybrid seeds were grown and the F_1 plants were back crossed to both parents to produce BC_{1a} and BC_{1b}. Also, the parents were recrossed to obtain more hybrid seeds and the F_1 plants were selfed to produce F_2 seeds.

In 2000 season, the six populations, i.e. the two parents (P_1 and P_2), F_1, the two back crosses (BC_{1a} and BC_{1b}) and F_2 were planted in a complete randomized block design with four replications, at Sakha Experimental Station. Each replicate block included two rows for each of the two parents and F_1 generation, four rows for BC_{1a} and BC_{1b} and ten rows of the F_2 generation. Plants were grown in rows 7.5 meter long and 60 cm wide. Each row had ten hills 75 cm apart. After 40 days all hills were thinned to single plant per hill. All the agricultural practices were done as recommended.

Eight characters were studied, i.e.:

1. Seed cotton yield (S.C.Y.) per plant in grams.
2. Lint cotton yield (L.C.Y.) per plant in gram.
3. Lint percentage (L%) as the amount of lint of seed cotton expressed in percentage.
4. Boll weight (B.W.) as the average weight (in grams) of five sound opened bolls. Picked at random for each plant.
5. Seed index (S.I.); weight in grams of 100 seeds taken at random from each plant.
6. Lint index (L.I.); the weight of lint produced by 100 seeds in grams, it was calculated according to the following formula:
   Lint index= lint percentage X seed index / (100 – lint percentage).
7. Days to the first flower; days from sowing to the appearance of the first flower.
8. Node number (N.N.) of the first fruiting branch.

Statistical procedures:

1. Potence ratio (P) was calculated from the formula given by Smith (1952):

$$P = \frac{F_1 - M.P}{\frac{1}{2}(P_2 - P_1)}$$

2. Heterosis was determined as percent of the deviation of F_1 hybrid versus its mid-parent (M.P) or versus better parent (B.P) values as follows:

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

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

Inbreeding depression was calculated from comparison held between F_2 and F_1 generations as follows:

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

Standard errors of difference for heterosis and inbreeding depression were calculated and t-test were then used to determine significant differences from zero.

3. Genetic components:

The statistical method using generation means was applied according to Gamble (1962) as follows:

Additive effect (a)= $BC_{1a} - BC_{1b}$

Dominance effect (d)= $-½ P_1 - ½ P_2 + F_1 - 4 F_2 + 2 BC_{1a} + 2 BC_{1b}$

Additive X Additive type of epistasis (aa)= $-4 F_2 + 2 BC_{1a} + 2 BC_{1b}$

Additive X Dominance type of epistasis (ad)= $-½ P_1 + ½ P_2 + BC_{1a} - BC_{1b}$

Dominance X Dominance type of epistasis (dd)= $P_1 + P_2 + 2F_1 + 4 F_2 - 4 BC_{1a} - 4 BC_{1b}$

The significance of the previous values were calculated by t-test as:

± t = effect / ? variance of effect

4. Heritability:

$$\text{Heritablity in broad sense} = \frac{? F_2 - VE}{VF_2} X100$$

Where VE = $^3? VP_1 . VP_2 . VF_1$

VE the environmental variance.

Heritablity in a narrow sense= $[2VF_2 - (VBC_{1a} + VBC_{1b})] / VF_2 X 100$

Mather (1949).

5. Expected genetic advance:

The predicted genetic advance from selection was calculated according to Allard (1960) as follows:

$GS = K X SA X h^2$

Where:

K = The selection differential which equals 2.06 upon selecting the highest 5% of the population.

SA = Phenotypic standard deviation of F_2.

H^2 = Heritablity in narrow sense.

$$G\% = \frac{GS}{F_2 \text{ mean}} X100$$

RESULTS AND DISCUSSION

Table (1) showed significant differences between the means of the two parents for seed cotton yield, lint yield, lint percentage and days to the first flower. The differences between means of the two parents were insignificant for boll weight, seed index and nod number of the first fruiting branches. Moreover, F_1, F_2, BC_{1a} and BC_{1b} showed the highest mean performance for seed cotton yield and lint cotton yield. These results may be attributed to the first parent (G. 84 X F. 108), which easily transmitted its performance into off spring. Hence, this variety could be utilized for improvement of these characters. Regarding for day to the first flower, the off spring generation except the BC_{1a} showed lowest number for days to first flower. This result may be attributed to the line of (G. 84 X F. 108). So this line could be utilized for improvement of earliness trait.

The data of potence ratio, heterosis, inbreeding depression, heritablity and genetic advance of the cross are given in Table (2).

Table 1: **Means of P_1, P_2, F_1, F_2, BC_{1a} and BC_{1b} of some economic traits in the cross (G. 84 X F. 108) X [G. 45 X (G. 45 X G. 84)].**

Characters	P_1	P_2	F_1	F_2	BC_{1a}	BC_{1b}
Seed cotton yield / plant	155.26 ± 3.80	91.18 ± 5.49	182.00 ± 7.91	129.32 ± 4.18	167.57 ± 5.09	159.66 ± 6.54
Lint cotton yield / plant	39.54 ± 1.16	27.91 ± 1.58	47.02 ± 2.33	35.72 ± 1.17	44.53 ± 1.46	41.51 ± 1.65
Lint percentage	25.21 ± 0.25	29.56 ± 0.37	25.61 ± 0.30	27.32 ± 0.18	25.46 ± 0.27	27.40 ± 0.23
Boll weight	2.29 ± 0.03	2.37 ± 0.04	2.37 ± 0.04	2.34 ± 0.02	2.36 ± 0.03	2.26 ± 0.03
Seed index	9.42 ± 0.08	9.34 ± 0.11	9.48 ± 0.09	9.62 ± 0.05	9.95 ± 0.07	9.34 ± 0.08
Lint index	3.24 ± 0.05	3.89 ± 0.06	3.41 ± 0.05	3.59 ± 0.03	3.45 ± 0.05	3.58 ± 0.04
Days to the first flower	79.50 ± 0.33	81.76 ± 0.32	79.69 ± 0.30	78.96 ± 0.18	79.04 ± 0.26	81.09 ± 0.26
Node number of the first fruiting branch	7.54 ± 0.09	7.88 ± 0.11	7.51 ± 0.11	7.39 ± 0.06	7.51 ± 0.08	7.77 ± 0.09

Table 2: **Estimates of potence ratio, heterosis, inbreeding depression, heritablity and genetic advance for some economic characters in the cross (G. 84 X F. 108) X [G. 45 X (G. 45 X G. 84)].**

Characters	Potence ratio	Heterosis %		Inbreeding depression	Heritablity%		Genetic advance	
		M.P+	B.P++		B.S	N.S	Value	%
Seed cotton yield/plant	1.84	47.71**	17.23**	28.95**	42.39	29.59	4.38	3.39
Lint cotton yield /plant	2.29	39.40**	18.92*	24.03*	39.86	36.12	2.82	7.88
Lint percentage	-0.8	-6.60*	-13.39*	-6.71*	18.72	16.62	0.52	1.91
Boll weight	1.08	1.93	0.13	1.43	22.70	13.45	0.14	6.06
Seed index	2.42	0.96	0.64	-1.50	10.47	3.23	0.05	0.54
Lint index	-0.47	-4.24*	-12.28*	-5.11*	14.93	8.27	0.10	2.88
Days to the first flower	-0.83	1.17	-0.24	0.93	16.37	4.00	1.23	1.55
Node number of the first fruiting branch	1.17	-2.50	-0.37	1.70	18.25	8.49	0 15	2.01

** **Significant at level 1%**
* **Significant at level 5%**
\+ **Mid-parent**
++ **Better-parent**

Table 3: **Estimates of Mather's scales (A, B, C), gene effect and type of epistasis for some economic characters in the cross (G. 84 X F. 108) X [G. 45 X (G. 45 X G. 84)] of extra long staple cotton.**

Characters	Mather's scales			Gene effect					Type of epistasis
	A	B	C	a	d	aa	ad	dd	
Seed cotton yield / plant	-2.12 ± 2.19	46.14 ± 2.47	-93.20 ± 3.57	7.91** ± 1.23	195.47** ± 3.64	137.18** ± 3.39	-24.13** ± 1.43	-181.01** ± 5.62	Duplication
Lint cotton yield / plant	2.50 ± 1.18	8.09 ± 1.29	-18.61 ± 1.93	3.03** ± 0.64	42.50** ± 1.92	29.20** ± 1.78	-2.80** ± 0.75	-39.79** ± 3.20	Duplication
Lint percentage	0.11 ± 0.46	-4.24 ± 0.48	3.31 ± 0.72	-1.93** ± 0.24	-5.35** ± 0.73	-3.57** ± 0.68	0.24 ± 0.29	3.82** ± 1.21	Duplication
Boll weight	0.06 ± 0.17	-0.22 ± 0.17	0.04 ± 0.26	0.11 ± 0.09	-0.06 ± 0.26	-0.11 ± 0.24	0.15 ± 0.33	0.26 ± 0.43	-
Seed index	1.00 ± 0.24	-0.12 ± 0.28	0.76 ± 0.39	0.61** ± 0.14	0.04 ± 0.13	0.11 ± 0.37	0.56** ± 0.16	-0.98 ± 0.67	-
Lint index	0.33 ± 0.21	-0.14 ± 0.21	0.41 ± 0.30	-0.13 ± 0.11	-0.44 ± 0.33	-0.29 ± 0.31	0.19 ± 0.13	0.18 ± 0.57	-
Days to the first flower	-1.11 ± 0.81	0.73 ± 0.48	-4.80 ± 0.72	-2.05** ± 0.25	3.50** ± 0.73	4.43** ± 0.68	-0.91** ± 0.30	-4.05** ± 1.22	Duplication
Node number of the first fruiting branch	-0.03 ± 0.27	0.15 ± 0.28	-0.88 ± 0.42	-0.26 ± 0.14	0.83 ± 0.90	1.12 ± 0.69	-0.09 ± 0.17	1.15 ± 0.70	-

** **Significant at level 1%**
* **Significant at level 5%**

The results cleared the presence of over dominance for seed cotton yield, lint yield, boll weight, seed index and node number of the first fruiting branch. The other characters were partial dominance. These results were in agreement with those obtained by Al-Hashash, 1987 and Abdel-Gelil, 2001 and El-Helew, 2002. Different results were obtained by Sallam *et al.*, 1985.

Table (2) showed significant positive heterotic effect versus mid parent and better parent for seed and lint cotton yield, while lint percentage and lint index gave significant negative mid-parent heterosis. These results were in harmony with those obtained by El-Kilany and Mazar (1985), Ismail *et al.* (1988) and Abd El-Gelil (2001). The traits of boll weight, node number and seed index showed insignificant heterotic effect. These results agreed with those obtained by Ismail *et al.* (1988). Different results were obtained by Al-Rawi and Kohel (1969), Sallam *et al.* (1985), Al-Hashash (1987).

Table (2) showed significant positive inbreeding depression for seed and lint cotton yield suggested the accumulation of additive gene effect which in turn increased the mean expression of these characters. Inbreeding depression was negative for lint percent and lint index indicated that genes were not completely segregated and mainly due to non fixable type. These results were in harmony with those obtained by Gomaa and Shaheen (1995), Abdel-Gelil (2001) and El-Helwe (2002). They found significant positive inbreeding depression for seed cotton yield and seed index, while it was significant negative for lint percentage. The other traits showed insignificant inbreeding depression.

Concerning heritablity estimates in broad and narrow senses, Table (2), showed relatively moderate values for seed cotton yield (42.39% and 29.58%), lint yield (39.86% and 36.12%), while relatively smaller and reliable values for lint percentage (18.72% and 16.62%), boll weight (22.69% and 13.34%), seed index (10.47% and 3.2%), lint index (14.93% and 8.26%), days to the first flower (16.37% and 4.1%) and node number (18.24% and 8.41%). Different results were obtained by Sallam *et al.* (1985), Al-Hashash (1987), Ismail *et al.* (1988), Abo Arab *et al.*(1994), Abdel-Gelil (2001) and El-Helw (2002).

The expected genetic advance from selecting five percentage of the better performance of the F2 population ranged from 7.88% for lint cotton yield to 0.54% for seed index.

These results indicated that the main part of genetic effect in the cross (G. 84 X F. 108) X [G. 45 X G. 84)] is non additive. At the same time, the high level of heterosis for seed cotton yield and lint and significant positive inbreeding depression for these traits suggested that the major part of genetic effect in this cross was non additive.

Testing for non-allelic interaction (A, B and C) together with the six parameters model and type of epistasis were given in Table (3). The results revealed the presence of the non-allelic interaction for all studied characters in this cross. It was worthy to mention that at least one of the A, B and C test was significant for the previous characters. These results may be taken an evidence for the failure of simple genetic model to a certain genetic variation for these characters in the corresponding cross. Therefore, the six parameters model was applied in order to assess the genetic interaction types controlling the genetic variation. The genetic component was obtained from partioning the variance of the population with regard to the type of gene effects, Table (3) showed that additive gene effects (a) were significant for all studied traits except for boll weight, lint index and node of the first flower, while dominance (d) were significant for seed cotton yield, lint yield and days to first flower. The results indicated that the dominance effects were greater in magnitude than additive effects for seed and lint yield. Among the epistatic components (dominance X dominance) were greater in magnitude than (additive X additive) and (additive X dominance), for seed cotton and lint yield while epistatic component (dominance X dominance) were equal magnitude with epistatic component (additive X additive) for days to first flower and lint percentage. Seed index showed significant (ad) epistatic component. These results were agreement with those obtained by Ismail *et al.* (1996) and El-Helw (2002). They found that (dominance X dominance) were significant for seed cotton yield and lint yield and El-Helw (2002) found that dominance X dominance (dd) were greater magnitude than additive X additive and additive X dominance for seed cotton yield.

The types of epistasis for seed cotton yield, lint yield, lint percentage and days to first flower were duplicate epistasis as revealed by differences in singe of (d) and (dd) which exhibited significant epistasis. These results were in harmony with that obtained by El-Disouqi *et al.* (2000) and El-Helw (2002).

Breeding implication:

The differences between the parental lines for seed cotton yield and lint yield were highly significant Table (1). This observation plus the relatively high level of heterosis, the presence over dominance and significant inbreeding depression verified by significant non additive dominance component and little magnitude for additive component within this material for improving these traits suggested that an effective breeding method for this population would be leading toward the production of the hybrids rather than varieties.

REFERENCES

Abdel-Gelil, M.A.B. (2001). Estimate of some Genetic parameters in two Egyptian cotton crosses.J.Agric.Sci.Mansoura Univ.,26 (8): 4631-4641.

Abo Arab, A.R.; A.E. Ayoub; I.A.I. Helal and E.A. El-Disiouqu (1994). Genetic studies on some characters in Egyptian cotton. J. Agric. Sci. Mansoura Univ., 19 (9): 2857-2867.

Al-Enani, Foraisa and F.M. Ismail (1986). Estimation of gene effect, inbreeding depression and heritablity in a cross of Egyptian cotton. Annats. Of Agric. Sc., Moshtohor, 24 (2): 787-793.

Al-Hashash, K.A.S. (1987). Genetic evaluation of some Egyptian cotton varieties. Ph.D. Thesis, Zagazig Univ.

Allam, M.A.M. (1992). Genetic studies of some economic characters in two Egyptian cotton crosses (G. 76 x G. 77) and (G. 68 x C.B. 58) x G. 45. M.Sc. Thesis, Al-Azhar Univ.

Allard, R.W. (1960). Principles of plant breeding. John Willey and Sons, Inc., New York.

Al-Rawi, K.M. and R.L. Kohel (1969). Diallel analysis of yield and other agronomic characters in *G. hirsutum* L. Crop. Sci., 9: 779-783.

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-Gohary, A.A.; Sallam, A.A. and El-Moghazi, M. (1981). Breeding potentials of some cultivated Egyptian cotton varieties.I- Heterosis and combining ability of seed cotton yield and its contributing varieties. Agric. Res. Rev., 59 (9): 1-17.

El-Helw, Sayeda S.H. (1981). Effect of some chemical and physical mutagens on *G. barbadense*. M.Sc. Thesis, Ain Shams Univ.

El-Helw, Sayeda S.H. (2002). Genetic parameters of some economic characters in the extra-long cotton cross "Giza 68 x Sea Island". Mansoura Univ., J. of Agric. Sci. vol. 27 No. (12), p 2011-2019.

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

Gambel, E.E. (1962).Gene effects in corn (*Zea mays* L.) II- Relative importance of gene effects for plant height and certain component attributes of yield. Canada J. Plant Sci., 42: 349-358.

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. Anual. Agric. Sci. Ain-Shams Univ. Cairo, 40 (1): 165-176.

Ismail, S.H.; A.A. Risha; H.F. Fahmy and H.M. Abd El-Naby (1988). Genetic studies of some economic characters in the Egyptian cotton cross (G. 77xG.45). Zagazig Univ. Fac. of Agric. Sci. Moshtohor, 26 (2): 907-917.

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

Mather, K. (1949). Biometrical genetics; the study of continuous variations. Dover policatims, Inc., London, 158p.

Sallam, A.A.; A.A. El-Gohary and M. El-Taweel (1985). Gene action in the inheritance of some characters in Egyptian cotton *G. barbadense* L. I- Seed cotton yield and some related characters. Assiut, J. Agric. Sci. 16 (2): 3-21.

Smith, H.H. (1952). Fixing transgressive vigour in *Nicotinana rustica*. Heterosis, Iowa State College. Press Ames, Iowa, U.S.A.

السلوك الوراثي لبعض الصفات الإقتصادية في هجين بين تركيبيسن وراثيين مـــن طبقة الأقطان فائقة الطول

محمد علاء الدين محمد علام
معهد بحوث القطن – مركز البحوث الزراعية – جيزة

أجري هذا البحث بمزرعة محطة البحوث الزراعية بسخا خلال ثلاث مواسم متتاليـة هـي ٩٨ ، ٩٩ ، ٢٠٠٠ لتقدير بعض القيم الوراثية مثل السيادة وقوة الهجين وأثر التربية الداخليـة وكفـاءة التوريـث وطبيعة الفعل الجيني في الهجين بين سلالتين هما (جـ ٨٤ × ف ١٠٨) الأب أول والثانية [جـ ٤٥ × (جـ ٤٥ × جـ ٨٤)] وقد تمت زراعة الآباء والجيل الأول والثاني والأجيال الرجعية لكل من الأبوين في تجربـة قطاعات كاملة العشوائية في أربع مكررات وقد أخذت البيانات على النباتات الفردية لكل جيل ويمكن تلخيص النتائج فيما يلي:

١. أظهرت النتائج سيادة تفوقية لكل من الصفات المدروسة ما عدا صفات تصافي الحليـج ومعـامل الشعر وتاريخ ظهور أول زهرة.
٢. كان تأثير قوة الهجين مقارنة بمتوسط الأبوين معنويا جدا وموجبا لصفات محصول النبـات مـن القطن الزهر ومحصول النبات من القطن الشعر بينما كانت عالية ومعنوية في تصافي الحليج.
٣. كان تأثير قوة الهجين مقارنة بمتوسط الأب الأحسن معنوية جدا في محصول النبات مـن القطـن الزهر بينما كانت معنوية فقط في محصول القطن الشعر بينما كانت معنوية وسالبة فـي تصـافي الحليج ومعامل الشعر.
٤. أظهرت نتائج الإنخفاض الراجع للتربية الداخلية قيم معنوية جدا في محصول النبات مـن القطـن الزهر ومعنوية فقط في محصوله من القطن الشعر وسالبة ومعنوية في تصافي الحليـج ومعـدل الحليج.
٥. كان تأثير الفعل الجيني الإضافي معنوى في الصفات المدروسة ما عـدا صفـات وزن اللـوزة ومعامل الشعر ورقم أول عقدة ثمرية.
٦. كان تأثير الفعل السيادى معنويا جدا في محصول النبات من القطن الزهر ومحصول النبات مـن القطن الشعر وتصافي الحليج وميعاد ظهور أول زهرة.
٧. كان تفاعل الفعل الجيني السيادى × السيادى أكثر أهمية مـن تفـاعل الإضـافي × الإضـافي ، الإضافي × السيادى لصفات محصول القطن الزهر والشعر.
٨. تراوح معامل التوريث بالمعنى العام من ٤٣,٣٩% إلى ١٠,٤٧% بينما في المعنى الخاص كـانت تتراوح من ٢٨,٥٨% إلى ٣,٢٣%.
٩. أظهرت النتائج أن السلالتين الأبويتين متقاربتين في معظم الصفات ماعدا محصول النبـات مـن القطن الزهر والقطن الشعر.
١٠. من النتائج السابقة يمكن استخلاص أن الهجين يمكن أن يستفاد منه في برنامج إنتاج القطن الهجين ويزيد الفرصة لإنتاج الأصناف.