J. Agric. Sci. Mansoura Univ., 32 (4): 2469 - 2476, 2007

ESTIMATES OF GENETIC COMPONENTS AND HERITABILITY FROM A DIALLEL CROSS IN EGYPTIAN COTTON

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ABSTRACT

A half diallel crosses involving five Egyptian cotton genotypes was used to study the inheritance of seed-cotton yield per plant and lint yield. The analysis of the F_1 generations and parents revealed that both additive and dominance gene effects were important in controlling the variation in the yield traits, but the effects of genes acting additively were more pronounced. The D parameter denoring additive variance was larger than the dominance H_1. Partial dominance was manifested for all studied traits. Narrow sense heritability was high for flowering time (0.81), seed-cotton yield (0.87) and lint yield (0.83) but low for lint percentage (0.18).

INTRODUCTION

Cotton is one of the most important sources of income in Egypt. Accordingly, the breeders focused their attention on improving yield of seed-cotton and fiber properties. For effective and rapid improvement in seed-cotton yield, through conventional breeding method, availability of variation among parents 5 in the initial crosses is essential. Estimates of general conbining ability (GCA) from a set of diallel crosses were found to be significant for all traits studied except lint percentage, which demonstrated the importance of additive gene effects of these traits with variance for specific combining ability (SCA) was significant only for lint percentage (El-Adl and Miller, 1971). El-Fawal *et al.* (1978) indicated that the GCA mean squares were significant for seed-cotton and lint yield suggesting that the genetic variation among F_1 hybrids was mainly associated with additive genetic effects while SCA estimates were small and significant only for boll weight. Garg *et al.* (1987) studied the triple-test cross using 45 families of upland cotton and found that the additive and dominance components of variation were significant for seed-cotton yield and gining outurn.

The additive gene effects were reported to be significant for all traits studied except number of bolls/plant and seed index with both broad and narrow senses heritabilities being high for all studied traits except fiber strength (Rahoumah *et al.*, 1989).

Awaad and Hassan (1996) reported that the simple additive-dominance genetic model was found to be appropriate for explaning the genetic system controlling boll weight and seed index. Also, the genetic system controlling seed-cotton yield and its component was studied by El-Ameen (1994). Who found that genes with additive-dominance effects were controlling lint percentage, while non-allelic gene interaction was operating for most traits.

Adel *et al.* (2004) found that dominance (h) was the main type of gene effects for all traits studied in cotton over two locations with the broad sense heritability being high for the studied traits studied.Highly significant heterotic effects were also obtained for most traits studied.

The present work was carried out in order to analyze the genetic basis of variation and to estimate heritability for seed-cotton yield and other related characters in Egyptian cotton (*Gossypium barbadense*).

MATERIALS AND METHODS

The basic material used in the present work consisted of five Egyptian cotton genotypes, namely, Giza-45, Dandara, Giza-83, Giza-85 and Giza-90.

In the 2002 season, the five parental genotypes were sown at the Experimental farm of Assiut University in 20th March. A half diallel crossing system was adopted for hybridization and all 10 crosses were made using hand emasculation. In 2003 season, the seeds of the five parents and their F_1 hybrids were field planted in a randomized complete block design with three replications. Each genotype represented in each replicate by 10 plants row where plants spaced 25 cm apart and rows were set 60 cm from each other. All agricultural recommendations were followed in this study. The analysis of data for flowring time, seed-cotton yield/plant, lint yield/plant and lint percentage was done according to the medthods of Hayman (1954) and Jinks (1954).

RESULTS AND DISCUSSION

I- F_1 Performance :

The analysis of variances among the different entries of the F_1 diallel cross of the four studied traits (Table 1) revealed highly significant differences among genotypes. The means of seed-cotton yield/plant (g) ranged from 37.63 gm for P_1(Giza-45)to 73.05 for P_2 (Giza-90). As for F_1's, the mean ranged from 53.17 for (P_1xP_5) to 82.19 for (P_2xP_3) hybrids. Meanwhile, mean lint yield/plant of the parents ranged from 10.39 to 27.99 g and from 20.08 g for (P_1xP_5) to 27.99 for (P_2xP_3) (see Table 3). Here to, lint percentage mean ranged from .28 for P_1(Giza-45) to .39 for P_3 (Giza-83), while the mean of flowering time from sowing date to the apearance of first flower ranged from 68 days for (P2 and P4) to 75 days for P_1 (see Table 5).

Table 1: The analysis of variance of four traits studied among the different entries of diallel table.

Item	d.f	Flowering time	Seed-cotton yield	Lint yield	Lint %
Blocks	2	2.90	28.68	31.88	0.003
Genotypes	14	10.84 **	323.47 **	49.28 **	0.002 **
Error	28	0.32	3.28	1.40	0.0002

Table 2: The means of seed-cotton yield/plant (g) of the F_1 diallel cross.

Parent	P_1	P_2	P_3	P_4	P_5	Array mean
P_1 (Giza–45)	37.63	61.53	62.68	59.54	53.17	54.91
P_2 (Giza–90)		73.05	82.19	76.98	65.53	71.85
P_3 (Giza–83)			70.78	78.61	66.02	72.05
P_4 (Dandara)				65.77	59.24	68.02
P_5 (Giza-85)					57.68	60.28

$\overline{P} = 60.98$, $\overline{F}_1 = 66.55$

Table 3: The means of lint yield/plant (g) of the F_1 diallel cross.

Parent	P_1	P_2	P_3	P_4	P_5	Array mean
G – 45 – P_1	10.39	21.14	22.54	21.53	20.08	19.14
G – 90 – P_2		27.99	28.83	27.97	23.95	25.97
G – 83 – P_3			27.26	27.60	22.90	25.82
Dandara – P_4				22.80	22.22	24.42
G – 85 – P_5					20.57	21.94

$\overline{P} = 21.80$, $\overline{F}_1 = 23.88$

Table (4): The means of lint% of the F_1 diallel cross.

Parent	P_1	P_2	P_3	P_4	P_5	Array mean
P_1 (Giza–45)	28	34	36	36	37	34
P_2 (Giza–90)		38	36	36	37	36
P_3 (Giza–83)			39	36	35	36
P_4 (Dandara)				36	37	36
P_5 (Giza-85)					36	36

$\overline{P} = 0.35$, $\overline{F}_1 = 0.36$

Table 5: The manes of flowering time of the F_1 diallel cross grown in 2003 growing season

Parent	P_1	P_2	P_3	P_4	P_5	Array mean
P_1 (Giza–45)	75	71	71	72	72	72.2
P_2 (Giza–90)		68	70	68	71	69.6
P_3 (Giza–83)			70	68	70	69.8
P_4 (Dandara)				69	71	69.4
P_5 (Giza-85)					73	71.4

$\overline{P} = 70.60$, $\overline{F}_1 = 70.63$

II- The diallel analysis :

Highly significant additive and non additive gene effects were indicated by the significance of "a" and "b" items (Table 6) for all traits studied. Similar results were obtained by El-Adl and Miller (1971), El-Fawal *et al.* (1977), El-Kadi *et al.* (1982) and Garg *et al.* (1989). The additive gene effects were greater than dominance gene effects for all studied traits in accordance with the results of El-Kadi *et al.* (1982). The significance of item "b_1" showed that F_1 hybrids exhibited directional dominance with the F_1 average exceeding that of the parents by 9.13% for seed-cotton yield/plant, 9.54% for lint yield/plant and 2.85% for lint percentage. Adel *et al.* (2004) reported highly significant heterotic effects for all traits studied. Significance of "b_2" item for all traits studied indicated asymetrical gene distribution of genes affecting at loci showing dominance, while the significant of "b_3" item indicated further dominance effects due to specific combinations. These results were in line with those obtained by El-Ameen (1994), Abd-ElZaher *et al.* (2003) and Adel *et al.* (2004).

Table 6: The diallel analysis of variance of flowering time, seed-cotton yield, lint yield and lint % of the F_1 diallel cross.

Item	d.f	Flowering time	Seed-cotton yield	Lint yield	Lint %
a	4	55.31 **	1714.41 **	254.02 **	0.002 **
b	10	3.89 **	90.58 **	16.69 **	0.002 **
b_1	1	0.01	371.76 **	51.67 **	0.0007
b_2	4	2.43 **	82.07 **	17.01 **	0.004 **
b_3	5	5.83 **	41.16 **	9.43 **	0.0005 **
B x a	8	0.48	3.84	1.67	0.0004
B x b	20	0.59	6.34	2.70	0.0005
B x b_1	2	0.37	2.23	2.11	0.001
B x b_2	8	0.47	8.69	3.32	0.0002
B x b_3	10	0.71	5.28	2.33	0.0006
Block interaction	28	0.32	3.28	1.40	0.0002

All items were tested against the block interaction.

The analyses of variance of (Wr + Vr) and (Wr-Vr) are shown in (Table 7) which revealed highly significant differences in (Wr + Vr) but non significant in (Wr – Vr) for all traits studied. Evidently additive-dominance mode of gene action was operating.

Table 7: Analyses of variance of (Wr + Vr) and (Wr – Vr) values for all studied traits of 2003 growing season.

Source of variation	d.f	Flowering time		Seed-cotton yield		Lint-yield		Lint percentage	
		Wr + Vr	Wr - Vr	Wr + Vr	Wr - Vr	Wr + Vr	Wr - Vr	Wr + Vr	Wr - Vr
Blocks	2	15.15	5.83	212.5	374.79	61.19	21.25	0.0000002	0.00000001
Array	4	35.27 **	0.32 Ns	8504.71**	279.29 Ns	746.03**	4.38 Ns	0.000004	0.0000002Ns
Error	8	4.03	0.31	836.28	94.15	52.58	4.64	0.00000004	0.00000009

The slope of the Wr/Vr regression line (Fig. 1) was significantly deviated from zero, but not from unity for all traits studied conferming the adequacy of the additive-dominance gene model. The estimates of the variance components of the genetic variation are tabulated in (Table 8). Array No. 1 having Giza-45 as common parent represented the extreme recessive genotype which was located at the end of the regression line for seed-cotton yield, lint yield and lint%, but the reverse was true for flowering.

a

b

Fig. 1 : The Wr/Vr graph of F_1 diallel cross for seed-cotton yield (above) and lint-yield (below).

a

b

Fig. 2: The Wr/Vr graph of F_1 diallel cross for flowering time (above) and lint% (below).

The "D" parameter estimating the additive variance was larger than dominance (H_1) confirming that partial dominance was operating, which was also indicated by the average degree of dominance being less than one for all traits studied. ElKadi *et al.* (1982) and Rahoumah *et al.* (1989) reported that partial dominance was operating for studied traits except seed-cotton yield with the F value being negative indicating an excess of recessive than dominant alleles. In this study the "F" value was positive for the flowering time, lint yield and lint% indicating an excess of dominant than recessive allels for these traits. The uv values were less than .25 indicating unequal distribution of the dominant and recessive allels among the five parents analyzed which has been indicated before from the significant "b_2" item. Narrow sense heritability esimates were high for flowering time (.81), seed cotton yield (.87) and lint yield .83 but low for lint% (.18). High estimates of heritability for these traits suggest that genetic improvement may be achieved through single plant and recurrent selection method.

These results were in agreement with those obtained by El-Fawal *et al.* (1977), Rahoumah *et al.* (1989), El-Ameen (1994), Abd-ElZaher *et al.* (2003) and Adel *et al.* (2004).

Table 8: Components of the genetic variation for flowering time, seed-cotton, lint yield and lint% of 2003 season.

Character	Flowering time		Seed – cotton yield		Lint yield		Lint %	
Item	X ± S. E		X ± S. E		X ± S. E		X ± S. E	
D	9.64	0.35	201.25	6.14	48.81	1.36	0.002	0.0002
F	2.69	0.88	-10.98	15.33	18.06	3.40	0.002	0.0004
H_1	2.24	0.96	68.27	16.57	10.86	3.68	0.001	0.0005
H_2	1.97	0.87	54.08	15.03	8.43	3.34	0.0007	0.0005
E	0.32	0.14	3.28	2.50	1.40	0.55	0.0002	0.00007
$(H_1/D)^{½}$	0.48		0.58		0.47		0.89	
UV	0.22		0.20		0.19		0.13	
Broad-sense H^2	0.92		0.95		0.93		0.52	
Narrow –sense h^2	0.81		0.87		0.83		0.18	

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تقدير المكونات الوراثية ودرجة التوريث فى تهجينات الدياليل فى القطن المصرى

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استخدم فى هذه الدراسة خمسة أصناف من القطن المصرى وهى جيزة ٤٥، ودندره، جيزة ٨٣، جيزة ٨٥، جيزة ٩٠ . تم زراعة هذه الأصناف فى موسم ٢٠٠٢ فى مزرعة تجارب جامعة أسيوط وتم التهجين بينها فى اتجاه واحد للحصول على بذور ١٠ هجن منها فى الجيل الأول . وفى موسم ٢٠٠٣ تم زراعة الآباء وهجن الجيل الأول فى تجربة قطاعات كاملة العشوائية . تم تحليل بيانات الآباء والجيل الأول لصفات محصول القطن الزهر – محصول الشعر – تصافى الحليج – التزهير باستخدام موديل هايمن ١٩٥٤، وأظهرت الدراسة النتائج التالية :

1- جميع الصفات محل الدراسة محكومة وراثياً بالطراز المضيف والسيادى من الفعل الجينى .
2- كان لطراز الفعل الجينى المضيف أكثر أهمية من فعل الجين السيادى لجميع الصفات المدروسة .
3- السيادة الجزئية كانت الغالبة فى الصفات التى تم دراستها .
4- درجة التوريث بمعناها الضيق والواسع كانت عالية لجميع الصفات ما عدا صفة تصافى الحليج.

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