J. Agric. Sci. Mansoura Univ., 28(5): 3317 - 3323, 2003

COMBINING ABILITY AND GENE ACTION IN SOME COTTON VARIETIES

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ABSTRACT

The present work was carried out during two successive seasons 2001 and 2002 at Sakha Agricultural Research Station to study general and specific combining abilities for the Egyptian cotton varieties: Giza 86, Giza 85, Giza 90 and Giza 83 (Lines) and Giza 70, Giza 89 and the Russian variety Karshenskey (testers), all belong to *Gossypium barbadense* L.

The dominance component of variance played a considerable role in controlling most characters except for boll weight, lint percentage and lint index, this was confirmed by low heritability values in narrow sense.

The estimates of the proportional contribution of lines were higher than those of testers for all studied characters except for seed cotton yield per plant and number of bolls per plant, while high estimates of the proportional contribution were obtained from the lines x testers interaction for seed cotton yield per plant, lint yield per plant and number of bolls per plants.

For mean values of yield and its components, Giza 86(L_1) showed the highest values for all characters, while Giza 90 (L_3) possessed the lowest estimates of most characters.

From the components of variance, it was clear that the environmental variance appeared to be of small effect on the expression of gene governing boll weight, lint percentage, seed index and lint index, while it had highly effective on seed cotton yield per plant, lint yield per plant and number of bolls per plant, these results were assured by heritability estimates in broad sense.

INTRODUCTION

In the last decades, there has been an increase in the number of cotton varieties, *Gossypium barbadense* L., available for production, most of these varieties were similar morphologically and in their yield production, due to the insufficient genetic variation among the Egyptian cotton. Since the continual use of such genetic resources has narrowed the genetic variation. Cotton breeders can utilize variability from available natural resources or increase it through hybridization.

One technique used extensively in corn and forage breeding programs has been used to classify parental lines in terms of their ability to be combined in hybrid combination. With this method the total genetic variation is partitioned into two parts; the variance for general combinating ability which includes the additives genetic portion, and that for specific combining ability which is usually defined to include non additive genetic portion arising, largely, from dominance and epistasis deviations.

Many investigators studied general and specific combining abilities on Egyptian cotton varieties among those, Sallam *et al.* (1981) and Abul-Naas *et al.* (1983); El-Kilany and Al-Mazar (1985), Jatagtap and Kolhe (1987), Okasha *et al.* (1998) and El-Disouqi and Ziena (2001) showed that both additive and dominance genetic effects were controlling the inheritance of lint percentage. Abo-Arab (1999) found that additive genetic variance was the predominant variance component controlling the inheritance of both boll weight and lint percentage. For the heritability, El-Kilany and Al-Mazar (1985) and El-Bana (1986) observed that the heritability in broad sense was more than 80% for lint percentage. Also, Al-Hashash (1987) found that the heritability in narrow sense estimates were 34.76 and 51.00% for lint percentage.

The main purpose of this investigation was to evaluate the parental lines and testers according to their general and specific combining abilities effect.

MATERIALS AND METHODS

This study was carried out at Sakha Agricultural Research Station, during the two successive seasons 2001 and 2002 on six Egyptian cotton varieties: Giza 86, Giza 85, Giza 90, Giza 83, Giza 70 and Giza 89 and one Russian variety, Karshenskye. Line x tester procedure, as outlined Kempthorne (1957) was applied.

In 2001 season, the parents (four lines and three testers) were sown, each was represented by three rows. Top crosses were made by using line x tester procedure. In 2002 season, the experiment was sown on April, 1 containing the twelve F_1-hybrids and their seven parents arranged in a randomized complete blocks design with three replications. Each entry was represented in each replication by three rows of 5 meters length. Hills, were spaced 60 cm apart comprising two plants for each. Normal cultural practices were applied as recommended for ordinary cotton growing.

At the end of the season, plants of each entry were harvested in order to examine the yield and yield components. These measurements were carried out as follows:

1- Seed cotton yield per plant (gm).
2- Lint yield per plant (gm).
3- Boll weight (gm).
4- Lint percentage %
5- Seed index gm.
6- Lint index.
7- Number of bolls/plant.

RESULTS AND DISCUSSION

1. Analysis of variance:

The analysis of variance (Table 1) showed highly significant mean squares of genotypes for all studied characters except for number of bolls per plant. these results indicate that these genotypes possess a sort of genetic variations for these characters, that probably due to their different backgrounds.

Partitioning of crosses mean squares to its three components, i.e., lines, testers and lines x testers, showed highly significant differences for lint percentage, seed index and lint index for lines variance, seed index and lint index for testers variance, while seed index was only significant for lines x testers interactions.

The ratios among the general and specific combining ability variances (Table 1) illustrated that the specific combining ability (dominance genetic variance) was the predominant variance component controlling the inheritance of most studied characters in spite of insignificant lines x testers interactions. This could be explained one the basis of internal cancellation of the contributions of the components of additive variance, which let dominance variance to appeared as a major component of genetic variance. This conclusion was also drown by Sallam *et al.* (1981), Al-Hashash (1987), Abo Arab *et al.* (1992) and Abo Arab (1999).

Table (1): Analysis of variance for all studied characters.

S.O.V.	d.F.	M.S.						
		Seed cotton yield/plant	Lint yield/plant	Boll weight gm.	Lint percentage %	Seed index gm	Lint index	Number of bolls/plant
Replications	2	71.9572	9.9094	0.0159	0.5160	0.0452	0.0110	25.8157
Genotypes:	18	702.4871**	93.9825**	0.16114**	5.1330**	0.7427**	0.5126**	62.5362
Parents (P)	6	986.0583**	154.2278**	0.0889	11.0137**	1.2088**	0.9299**	148.4911*
Crosses (C)	11	449.7574	53.0999	0.0632	2.3445*	0.5405**	0.3310**	53.3197
(P) vs. (C)	1	1781.0859**	182.2188*	1.6768**	0.5234	0.1709*	0.0063	8.1875
Crosses:								
Lines (L)	3	312.8629	58.1937	0.1393	5.4744**	1.3187**	0.9796**	26.0574
Testers (T)	2	576.4349	71.7119	0.0253	0.4056	0.6542**	0.2434*	88.2129
(L) x (T)	6	475.9789	44.3490	0.0378	1.4258	0.1134*	0.0359	55.3198
Error	36	225.5279	29.5450	0.0524	1.0464	0.0408	0.0583	45.3058

***, ** significant at 0.05 and 0.01 level, respectively.**

Table (2): Mean values for all studied characters for all genotypes.

Genotypes	Seed cotton yield/plant	Lint yield/plant	Boll weight gm.	Lint percentage %	Seed index gm	Lint index	Number of bolls/plant
Giza 86 (L_1)	89.7 a	32.9 a	2.6 b-d	36.8 a	9.4 a	5.5 a	34.7
Giza 65 (L_2)	54.1 e	18.5 h	2.2 fg	34.3 d	8.7 c	4.8 cd	24.9
Giza 90 (L_3)	31.3 f	9.7 i	2.3 e-g	32.0 g	8.7 c	4.1 fg	14.0
C'za 83 (L_4)	71.2 b-d	26.2 c-f	2.4 d-f	36.9 a	7.7 h	4.5 de	29.3
Karesh. (T_1)	72.2 b-d	24.9 d-g	2.2 fg	34.6 cd	8.2 f	4.3 ef	33.1
Giza 70 (T_2)	87.5 de	21.8 f-h	2.1 g	32.4 fg	7.6 h	3.8 h	32.2
Giza 89 (T_3)	68.8 b-d	23.4 e-h	2.3 e-g	33.9 de	8.5 d	4.3 ef	29.5
$L_1 \times T_1$	88.3 a	30.58 a-c	2.8 ab	34.6 cd	9.0 b	4.6 bc	32.7
$L_1 \times T_2$	90.8 a	31.4 ab	2.9 a	34.5 cd	9.3 a	4.9 b	31.1
$L_1 \times T_3$	62.5 de	22.0 f-h	2.8 ab	35.3 bc	8.8 c	4.8 bc	22.3
$L_2 \times T_1$	68.3 c-e	22.9 e-h	2.6 b-d	33.6 e	7.9 g	4.0 g	26.1
$L_2 \times T_2$	67.5 a	25.8 c-f	2.6 b-d	33.1 ef	8.6 c	4.3 ef	33.4
$L_2 \times T_3$	67.9 b-d	22.9 e-h	2.7 a-c	33.8 de	8.4 de	4.3 ef	25.5
$L_3 \times T_1$	59.6 de	20.2 gh	2.6 b-d	34.0 de	7.9 g	4.0 g	23.6
$L_3 \times T_2$	65.2 de	25.0 d-g	2.4 d-f	33.6 e	6 2 f	4 2 fg	20 1
$L_3 \times T_3$	82.7 ab	27.3 b-e3	2.6 b-d	33.1 ef	8.3 ef	4.1 fg	31 4
$L_4 \times T_1$	69.7 b-d	23.6 e-h	2.5 c-e	33.8 de	8.4 de	4.3 ef	28.0
$L_4 \times T_2$	94.3 a	33.7 a	2.6 b-d	35.5 b	8.8 c	4.9 b	36.3
$L_4 \times T_3$	82.1 a-c	29 1 a-d	2.7 a-c	35.3 bc	8.5 d	4.6 cd	30.3

Mean values of yield and its components for all genotypes are presented in Table (2). Data revealed that Giza 86 (L_1) showed the highest values for all studied characters, while Giza 90 (L_3) possessed the lowest estimates of most studied characters. The F_1 hybrids (Giza 86 x Giza 70), (Giza 86 x Karsh.), (Giza 83 x Giza 70) and (Giza 83 x Giza 89) showed high performance for most studied characters. These results were in agreement with those obtained by El-Helw (1990) and Dagaonkar and Malkhandale (1993).

2. General combining ability effects:

The general combining ability effects of lines and testers for all studied characters are presented in Table (3). concerning lint percentage, Giza 83 (L_4) had significant positive and desirable g.c.a. effect, while significant negative g.c.a. effect was detected for Giza 85 (L_2).

The other lines and testers showed undesirable positive or negative g.c.a. estimates for the other characters. Therefore, Giza 83 (L_3) could be considered as combiner for lint percentage.

Table (3): General combining ability effects for all studied characters.

Parents	Seed cotton yield/plant	Lint yield/plant	Boll weight gm.	Lint percentage %	Seed index gm	Lint index	Number of bolls/plant
Lines:							
Giza 86	3.9528	1.7806	0.1778	0.5889	0.5056	0.3694	-0.3278
Giza 85	-1.9917	-2.3528	-0.0222	-0.7111*	-0.1611	-0.2194	-0.7167
Giza 90	-7.4139	-2.0063	-0.1111	-0.6333	-0.3944	-0.3306	-1.4167
Giza 83	5.4528	2.5806	-0.0444	0.7556*	0.0500	0.1806	2.4611
Testers:							
Karesh.	-5.1111	-1.8889	-0.0306	-0.2028	-0.2278	-0.1500	-1.4472
Giza 70	7.6889	2.7611	-0.0222	0.0472	0.2389	0.1333	3.1278
Giza 89	-2.7778	-0.8722	0.0528	0.1556	-0.0111	0.0167	-1.6806
L.S.D. (g_i - g_j) line at 0.05	14.300	5.176	0.218	0.974	1.923	0.229	6.409
L.S.D. (g_i-g_j) testers at 0.05	12.384	4.482	0.189	0.843	1.666	0.199	5.551

3. Specific combining ability effects:

The specific combining ability effects of twelve F_1's for all studied traits are shown in Table (4). Positive s.c.a. value of any cross means that the F_1 generation of this cross would produce higher value relative to the average.

Performance of its parents and the magnitude of heterosis would depend on the value of the specific combining ability effect. Concerning all characters under investigation, none of the crosses exhibited favourable estimates of s.c.a. effect.

Normally, specific combining ability would not contribute directly to the improvement of self-pollinated crops except where commercial exploitation of heterosis is possible. Also, the general combining ability effects of the parental lines were not, generally, related to specific combining ability values of their corresponding crosses.

Sakr (1974), Sallam (1977), Abo-Arab *et al.* (1992) and Abo Arab (1999) reported that parents with high g.c.a. effects did not necessarily produce hybrids with high s.c.a. effects.

Table (4): Specific combining ability effects for all studied characters.

Genotypes	Seed cotton yield/plant	Lint yield/plant	Boll weight gm.	Lint percentage %	Seed index gm	Lint index	Number of bolls/plant
Giza 86 x Karesh.	12.8556	4.4444	-0.0361	0.0028	0.1944	0.1056	5.4694
Giza 86 x Giza 70	2.3889	0.6611	0.1222	-0.3139	-0.0056	-0.0778	-0.7056
Giza 86 x Giza 89	-15.2494	-5.1056	-0.0861	0.3111	-0.18889	-0.0278	-4.7639
Giza 85 x Karesh.	-1.1333	0.9111	-0.0028	0.3361	-0.2389*	-0.0389	-0.7750
Giza 85 x Giza 70	5.0333	-0.8389	0.0222	-0.4472	0.1611	-0.0222	1.9167
Giza 85 x Giza 89	-3.9000	-0.0722	-0.0194	0.1111	0.0778	0.0611	-1.1417
Giza 90 x Karesh.	-4.4778	-2.0667	0.1194	0.6250	-0.0389	0.0722	-2.6083
Giza 90 x Giza 70	-11.8444	-1.9500	-0.1556	0.0083	-0.1389	-0.0444	-2.8500
Giza 90 x Giza 89	16.3222	4.0167	0.0361	-0.6333	0.1778	-0.0278	5.4583
Giza 83 x Karesh.	-7.2444	-3.2889	-0.0806	-0.96.39	0.0833	-0.1389	-2.0861
Giza 83 x Giza 70	4.4222	2.1278	0.0111	0.7528	-0.0167	0.1444	1.6389
Giza 83 x Giza 89	2.8222	1.1611	0.0694	0.2111	-0.0667	-0.0056	0.4472
L.S.D. (S_{ij} - S_{kl}) at 0.05	24.769	8.965	0.377	1.687	0.333	0.398	11.101

4. Proportional contribution of lines, testers and their interactions:

The values of proportional contribution of lines, testers and their interactions are presented in Table (5) as sum squares of these genotypes relative to the sum squares of crosses.

The estimates of the proportional contribution of lines were higher than those of testes for all studied characters except for seed cotton yield per plant and number of bolls per plant, while high estimates of the proportional contribution were obtained from the lines x testers interaction for seed cotton yield per plant, lint yield per plant and number of bolls per plant compared with the other values either for liens or testers. This indicates the unequal magnitude of the role of either lines or testers in the expression of the specific combining ability and heterosis in all studied crosses. these results were in agreement with those obtained by Abo-Arab *et al.* (1992) and Abo Arab (1999).

Table (5): Proportional contribution of lines, testers and their interaction for all studied characters.

Contribution	Seed cotton yield/plant	Lint yield/plant	Boll weight gm.	Lint percentage %	Seed index gm	Lint index	Number of bolls/plant
Lines (L)	18.97	29.89	60.07	63.68	66.54	80.71	13.33
Testers (T)	23.30	24.55	7.28	3.15	22.01	13.37	30.08
(L) x (T)	57.73	45.56	32.65	33.17	11.45	5.92	56.59

5. Component of variance:

Data in Table (6) show that the dominance component of variance played a considerable role in controlling most characters except for boll weight, lint percentage and lint index compared with the additive components, this result was confirmed by slightly estimates of narrow heritability values. Abo-Arab (1999) found that additive genetic variance was the predominant variance component controlling the inheritance of both boll weight and lint percentage.

Table (6): Components of variance and heritability estimates for all studied. characters.

Parameters	Seed cotton yield/plant	Lint yield/plant	Boll weight gm.	Lint percentage %	Seed index gm	Lint index	Number of bolls/plant
σ^2 A	0.000	0.7550	2.1910	7.9256	3.6842	2.5460	0.0000
σ^2 D	83.4836	4.9347	0.0000	0.1265	2.4203	0.0000	3.3380
σ^2 G	83.4836	5.6897	2.1910	8.0521	6.1045	2.5460	3.3380
σ^2 e	75.1760	9.8483	0.0175	0.3488	0.0136	0.0194	15.1019
σ^2 P	158.6596	15.5380	2.2085	8.4009	6.1181	2.5654	18.4399
h^2 (b) %	52.6181	36.6180	99.2076	95.8481	99.7777	99.2438	18.1021
h^2 (n) %	0.0000	4.8591	99.2076	94.3423	60.2180	99.2438	0.000

Ultimately, the environmental component of variance appeared to be of small effect on the expression of gene controlling boll weight, lint percentage, seed index and lint index, while this component of variance was highly effective on seed cotton yield per plant, lint yield per plant and number of bolls per plant, these results were confirmed by heritability in broad sense. Similar results were obtained by El-Kilany and Al-Mazar (1985), El-Bana (1986), Abo-Arab *et al.* (1992), Al-Zanati (1993) and Abo-Arab (1999) and El-Disouqi and Ziena (2001).

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القدرة على التآلف والفعل الجينى فى بعض أصناف القطن

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أجرى هذا البحث لدراسة القدرة العامة والخاصة على التآلف وتضمنت الدراسة سبعة أصناف منها ستة أصناف مصرية وهى جيزه ٨٦ ، جيزه ٨٥ ، جيزه ٩٠ ، جيزه ٨٣ ، جيزه ٧٠ ، جيزه ٨٩ وصنف روسى هو كارشنسكى وجميعها يتبع *G. barbadense*. وأجريت التجربة بمحطة البحوث الزراعية بسخا موسمى ٢٠٠١ ، ٢٠٠٢م.

فى موسم ٢٠٠١م تم زراعة البذرة الذاتية لهذه الأصناف وتم التهجين بطريقة Line X tester للحصول على الهجن القمية.

وفى موسم ٢٠٠٢م زرعت الأباء والهجن الناتجة فى تجربة ذات تصميم قطاعات كاملة العشوائية فى ثلاث مكررات وفى نهاية الموسم تم جنى كل التراكيب الوراثية كل على حده.

وفيما يلى ملخص لأهم النتائج المتحصل عليها:

١- كان للتأثير السيادى الدور الأساسى فى وراثة معظم الصفات المدروسة وهذا تأكد بإنخفاض الكفاءة الوراثية بمعناها الضيق.
٢- كان للأصناف الـ Lines دور أهم من الـ testers فى الهجن القمية للصفات المدروسة عدا صفتى محصول القطن الزهر/نبات وعدد اللوز/نبات. والتى كان للتفاعل Lines X testers الدور الأهم فيها.
٣- أعطى الصنف جيزه ٨٦ (L_1) أعلى القيم لجميع الصفات المدروسة بينما أعطى الصنف جيزه ٩٠ (L_3) أقل القيم لها.
٤- كان للتباين البيئى تأثير واضح على صفات محصول القطن الزهر/نبات ومحصول القطن الشعر/نبات وكذلك عدد اللوز على النبات بينما كان التأثير أقل وضوحا على صفات وزن اللوزة ومعدل الحليج ومعامل البذره وكذلك معامل الشعر.