Proceeding Fifth Plant Breeding Conference May 27, 2007 (Giza)

Egypt. J. Plant Breed. 11(2): 813-827 (2007) Special Issue

INTER AND INTRASPECIFIC COTTON CROSSES 2-VARIANCES ESTIMATES AND COMBINING ABILITY OF F_1 AND F_2 CROSSES TARGETED GROWTH, EARLINESS AND YIELD VARIABLES

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ABSTRACT

Interests were given to the genetic abounds of genes for improved mechanically harvested cottons in the American-breed genotypes. However, their combining ability with Egyptian cottons with this regard is unknown. With the exploiting of the without-reciprocal diallel mating design among five diverse cotton lines, variance estimates and effects of combining ability were calculated for growth, earliness and yield cotton characters based on data collected from F_1 and F_2 cotton cross populations. The nature of inheritance for these variables was targeted too. Field experimentation; parents and generations were grown at Cairo University experimental farm in 2004 and 2006. The results showed that, that the nature of gene action was predominantly non-additive for earliness index, number of bolls per plat and lint cotton yield. The additive gene action was observed for the rest of character. General combining ability effects (GCA) for the five parents varied significantly for growth, earliness and yield, in addition to between generations. The genotype G85 from Egyptian category was the best overall general combiner; it showed positive GCA effects for the majority of the studied traits. Besides, it was combined well with the selected U.S. cultivars chosen for this study i.e., P6, Tamcot and wild strain. Thus, it would be a good source of parental germplasm for improving traits like node number of first fruiting branch, number of fruiting branches and earliness index. The Tamcot SP and wild accessions were good general combiner for the majority of growth and yield components especially boll weight. Seed cotton yield and lint cotton yield tended to increase when these parents was used. Tamcot SP and wild accession can be also used as donor parents to provide short PH, DFF and DFB genes. The study tends to recommend the varieties G85, P6, Tamcot and their dependent filial generation to start selection program towards an Egyptian plant types that can be picked by machine.

Key words: *Egyptian cottons- American cottons- Diallel mating- Combining ability- Genetic parameters- Machine harvested cotton.*

INTRODUCTION

Germplasm manipulation and planting position of current Egyptian cotton cultivars in crop rotation became very sensitive that must affect the quality and total production in domestic and world markets. Egyptian cotton can be described as tall, luxuriant plant, which, despite its great quality, is not breed to fit modern mechanization levels. Works introduced to evaluate the breeding potential of Egyptian cottons to be integral with mechanical harvesting are rare. The reasons for that were due to the existence of affordable labors and awareness of the effect of these conditions on our quality prized cottons. Besides, the expected extra cost of introducing and implementing this technology. With the lack of published reports on this context, Abdalla *et al* (2005) initiated a preliminary study to evaluate the possibility of growing Egyptian cottons under fully mechanized system, with emphasizing the mechanical picking, in addition to find out the basic requirements for machine-harvested cotton under Egyptian conditions and its effect on the lint yield, quality and test the additional machinery levels necessary for serving the cotton production under these conditions. They reached a conclusion that long way needs to be passed through before seeing an Egyptian genotype can be economically harvested by machine.

Inducing useful genetic diversity among cotton genotypes facilitates the creation of segregating populations for selecting plants with desired gene combinations. Diallel and other mating designs are rules for arranging controlled crossing, these rules were initially derived to allow the estimation of genetic parameters and create the next generation. The theory of diallel analysis showed that the term diallel refers to any one of several procedures by which genetic variances are partitioned from diallel crosses (Hyman 1954 and Griffing 1956). Diallel analysis have been recommended by many researchers for further evaluation of genotypes resulted from a large number of lines screened based on North Carolina approach with a wide genetic base tester (Chahal *et al* 1978). Moreover, evaluation of breeding capacity in means of mean performance and mode of gene introgression of the within cotton germplasm repositories is warranted to identify populations with vigor potential than those currently adopted (Gutie´rrez *et al*. 2002). Despite drawbacks related to interspecific cotton hybridization, it seems that the hybrids between the two tetraploid cottons species tend to combine the high yielding ability of *G. hirsutum* and the acceptable level fiber quality of *G. barbadense* (Abdalla 2006). Given the "upland" (Wells and Meredith Jr.1986) and "Pima" (Abdalla *et al* 1999) germplasm ability to generate broad-base and mechanically harvested genotypes, it may be possible to select variants aiding in fulfilling the study breeding objectives. It is inferred from the review article presented by Percival and Kohel (1991) that the cotton yield improvement attained reflects an increased emphasis on inter-mating between diverse cotton germplasm especially between the improved variants of the two tetraploid species of *barbadense* and *hirsutum*.

Therefore, with the aim of developing a practical base to start selection program for cotton ecotypes fitted to machine harvesting, the current study is utilizing cotton crosses of F_1 and F_2 of inter and intraspecific populations resulted from a half diallel matings involving five parents (two Egyptian genotypes, one Egyptian-American genotype, and two upland genotype) to identify hybrid progenies with superior potential for growth, yield and earliness of cotton genotypes through eliciting information on combining ability and gene action.

MATERIAL AND METHODS

Breeding scheme and crop monitoring

Five cotton genotypes from diverse breeding background were selected as parents and crossed in a half-diallel mating design in 2004. The breeding materials history, genetic fixation, and crosses generation described in details by Abdalla 2007. The experiments were conducted at Cairo University Agriculture Experiment Station. In 2004 a set of three *G. barbadense* genotypes *viz.*, G89, G85, Pima S6 and two *G. hirsutum* genotypes/lines *viz.*, Tamcot SP and Wild were used after three years selfing and crossed in a diallel mating design set of 5X5 (without reciprocal) to develop ten F_1 crosses. The genotypes were symbolized G for Giza, P6 for Pima S6, Tamcot and Wild. In 2005 season, parents were recrossed from the same seed stock to obtain more hybrid seeds and F_1 were artificially selfed to obtain F_2 seeds. On March 29, 2006 selfed seed of parents and their filial generations were planted in RCBD trial with four replications. The lay out included two adjoins field trials; first one contained parents and F_1 and the second one contained parents and F_2. The ridges were 5m long and 0.60m apart. Sowing was done in hills spaced 0.25m apart. Soon after complete emergence, seedlings were thinned to one plant per hill. Plants of each parents and hybrids were grown in one ridge. With the exception of using recommended growth regulators for enhancing yield and uniform growing as normally settle on machine-harvested cottons, standard crop management practices were followed including pest control.

Data collecting and statistical breakdown

After seedling became well established, Five representative plants were tagged from each plot to provide the following data: growth and earliness variables were plant height (PH/cm), number of fruiting branches (NFB), node number of first fruiting branch (NFFB), date of first flower (DFF/day)–number of days from planting to appearance of first flower, date of first open boll (DFB/day)–number of days from planting to opening of the first boll and boll maturation period (BP/day)–the time from anthesis of the flower until the resulting boll was sufficiently open to see the lint. Additional five guarded plants from each plot were hand harvested at three frequent intervals until all bolls had been harvested. Their mean values were used for statistical analysis for the following characters: number of harvested bolls per plant (NB/p), boll weight (BW) gm- average weight in grams of fifty-sound, opened, random, bolls, lint percentage (L %)-the amount of lint in seed cotton sample, expressed as percentage, seed index(SI) gm-Estimated as 100 seed weight in gm, seed cotton yield (SCY/p) gm-mean weight of sampled plants and earliness index(EI)–ratio of weight of seed cotton harvested at the first picking to total weight of seed cotton harvested, expressed as a percentage.

Analysis of variation for growth, earliness and yield variables was done using the F_1 and F_2 crosses population derived from hybridization between aforementioned inbred lines following the cross-reference of Griffing (1956). The statistical analyses were based on plot means from the data collected on individual plants. For justifying the significance among breeding materials data were, first, subjected to regular analysis of variance using RCBD with four replications of each trail, based on plot means of the data following Steel and Torrie (1980). Providing the existence of the Griffing's biometrical model to test the null hypothesis of $\sigma^2_g=0$ and $\sigma^2_s=0$, the combining ability analysis was carried out using Method II of Griffing (1956) i.e. including parents, their crosses and confined with the random effect model. Genetic components of variation were also obtained using the procedures described by Sharma (1998).

RESULTS

Combing ability (GCA, SCA) and G/S analysis of variation

The analysis of variance for general combining ability (GCA) and specific combining ability (SCA) for growth variables i.e. PH, NFB and NFFB and earliness variable i.e. DFF, DFB, BP and EI at the two populations are presented in Table (1).

Table 1. Mean squares of GCA and SCA for growth, earliness and yield variables of cotton hybrids

	*Sources*ʘ							
	GCA	SCA	GCA/SCA	MS_e	GCA	SCA	GCA/SCA	MS_e
df	4.00	9.00		42.00	4.00	9.00		42.00
	F_1				F_2			
Variables●	Growth variables							
PH	516.80**	210.09**	2.46	33.37	414.09**	236.18*	1.75	54.41
NFB	15.09**	13.60**	1.11	3.47	7.58**	6.00**	1.26	2.05
NFFB	1.36*	0.50	2.72	0.52	0.57**	0.18	3.17	0.16
	Earliness variables							
DFF	7.21**	3.88**	1.86	1.25	9.70**	2.05*	4.73	0.89
DFB	13.51**	7.09**	1.91	2.11	8.43**	2.38*	3.54	0.93
BP	4.44*	1.60	2.78	1.67	2.15*	1.25	1.72	0.85
EI	6.88*	8.09**	0.85	20.03	3.50	7.65**	0.46	25.50
	Yield variables							
NB/P	20.12*	30.15**	0.67	7.68	22.15	38.73**	0.57	9.65
BW	1.01**	0.57*	1.77	0.22	0.56**	0.34	1.65	0.15
SI	5.25**	4.65**	1.13	1.48	2.30*	1.03	2.23	0.75
L%	40.90**	7.45	5.49	5.15	38.73**	12.76	3.04	10.15
SCY	684.09**	351.00**	1.95	174.12	346.57**	405.44**	0.85	110.47
LCY	189.23**	190.32**	0.99	35.63	167.43**	175.00**	0.96	42.84

● Plant height (PH cm), Number of fruiting branches (NFB), the node number of first fruiting Branch (NFFB),Date of first flower (DFF day), Date of first open boll (DFB day), boll period (BP day), earliness index (EI), number of harvested bolls per plant (NB/p), seed cotton yield per plant (SCY/p) and lint cotton yield per plant (LCY/p). ʘ degrees of freedom (df), general combining ability (GCA), specific combining ability (SCA) and the error mean square for combining ability (MS_e). *, ** Significant at 0.05 and 0.01 levels of probability.

The GCA variances were highly significant for PH and NFB at the two populations. The NFFB variances were highly significant with the F_2 and significant with the F_1. The GCA variances were highly significant for DFF and DFB at the two populations. The BP variances just passed the 0.05 level of significance at the two generations. EI variances were significant only with the F_1 generation. The SCA variances due to NFB were highly significant at the two generations. PH variance was significant at the F_2 and exceeds the 0.01 level of significance at the F_1. NFFB variances were in no generation significant. The SCA variances at F_1 population were highly significant with DFF, DFB and EI. The SCA variances at F_2 were highly significant with EI, whereas were significant with DFF and DFB. The variances due to SCA associated with BP in no generation reached 5 % level of significance. The breakdown of the combinability mean squares into variances due to GCA and SCA for yield and major contributing variables are in Table (1).

The results with F_1 pointed out that the variances due to GCA were highly significant for BW, L%, SCY and LCY, whereas EI and NB/p were significant. The F_2 results were highly significant with BW, L% and LCY, whereas SI and SCY were significant, NB/p were insignificant. The relative magnitude of variances due to GCA for all characters at the two populations was more than that due to SCA except for SCY at the F_2 population and EI, NB/p and LCY at the two populations (Table 1). The GCA/SCA ratio indicated that the nature of gene action was predominantly non-additive for EI, NB/p and LCY. The additive gene action, however, was observed for the rest of character. Significant SCA for yield and the break up the SS into variances due to GCA and SCA effects (Table 3) revealed that the variance due to GCA effects was more than SCA effects at the two populations for BW, L%, SI and SCY(F_2 only). The opposite direction was observed for EI, NB/p and LCY/p. It could be concluded that the nature of gene action was mainly additive for BW and L%, non-additive for NB/p and SCY/p and both additive and dominance for seed index. The over all findings revealed that both additive and non additive genetic effects were important in the expression of these characters. These findings are more or less in conformity with earlier reports as that obtained by Marani (1964).

GCA effects

Estimates of GCA effects are presented in Table (2). Results indicated that the three growth traits i.e. PH, NFFB and NFB showed positive effects with the three *barbadense* genotypes at the two populations except for NFFB with P6 at F_1 generation. The *hirsutum* genotypes significantly showed the exact opposite direction with the three characters. The genotypes G89 and G85 were significantly positive combiners for PH at the two populations, whereas the two *hirsutum* genotypes were negatively significant for this character at the two generations. Positive significant GCA recorded by the genotype G85 at F_2

Table 2. GCA effects estimates for growth, earliness and yield variables based on F_1 and F_2 cotton crosses variations.

F_1						F_2					
Parent	G89	P6	G85	Wild	Tamcot	Parent	G89	P6	G85	Wild	Tamcot
Growth Variable ●						Growth variables*					
PH	2.98*	1.02	2.05*	-4.30*	1.29	PH	3.98*	3.14	3.79*	-6.49*	-3.87*
NFFB	0.08	-0.26*	0.06	-0.61*	-0.25*	NFFB	0.11	0.04	0.15*	-0.18*	-0.08
NFB	0.34	3.13*	1.65*	-1.02*	-0.39	NFB	0.36	1.87*	1.11*	-0.2	-1.03*
Earliness variables						Earliness variables					
DFF	0.01	-0.31	-0.04	-0.53*	-0.41*	DFF	0.04	-0.90*	0.03	-0.47*	-0.46*
DFB	0.01	-0.24	0.12	-0.50*	-0.48*	DFB	0.13	-0.27	-0.12	-0.34*	-0.39*
BP	0.16	0.13	0.12	-0.3	-0.41*	BP	1.05	0.1	1.12	-0.22	0.15
EI	-2.51	0.65*	-0.06	2.04*	0.92*	EI	-2.8	0.33	0.59*	1.93*	0.57*
Yield variables						Yield variables					
NB/P	1.05*	1.30*	-0.08	-1.01*	0.09	NB/P	0.89	1.34*	-0.94	-0.94	0.26
BW	0.08	-0.11	0.14	0.34*	0.26*	BW	0.12	-0.4	0.15*	0.60*	0.19*
SI	-0.31	-0.26	0.76*	1.94*	1.06*	SI	-0.1	-0.09	-0.43	2.02*	0.81*
L%	0.94*	2.25*	0.72	0.03	0.23	L%	0.99	2.04*	1.02*	1.02	-0.06
SCY	2.34	3.04	4.38*	4.12	2.49	SCY	-1.7	-1.37	1.97	1.95	1.44
LCY	2.13*	-0.03	1.09	1.03	0.09	LCY	1.94	2.31*	0.34	1.66	0.56

● Plant height (PH cm), Number of fruiting branches (NFB), the node number of first fruiting Branch (NFFB),Date of first flower (DFF day), Date of first open boll (DFB day), boll period (BP day), earliness index (EI), number of harvested bolls per plant (NB/p), seed cotton yield per plant (SCY/p) and lint cotton yield per plant (LCY/p). * Significant at 0.05 level of probability.

with respect to NFFB, whereas the genotypes P6, Wild and Tamcot were negatively greater than their relevant standard error level (Tables 2 and 4). TheNFB showed positive and significant GCA with P6 and G85 at the two populations, but was negative and significant with wild *hirsutum* at F_1 and Tamcot at F_2. Estimation of GCA earliness variables are presented in Table (2).

The DFF and DFB exhibited significant negative effects at the two populations for the *hirsutum* genotypes Tamcot and Wild indicating that these varieties are good combiners for earliness in this respect. On the other hand, the *barbadense* genotypes G85 and G89 proved to be very low combiners, whereas P6 provided significant negative effects with DFF at the F_2 only. Negative but significant GCA recorded only by Tamcot at the F_2 with respect to BP. With respect to earliness index, the GCA effects were negative and significant i.e. towards lateness for Giza 89 and G85 in the F_1 and G89 at the F_2. P6 showed positive effects but only significant with the F_1 populations. The both *hirsutum* parents were significantly positive towards earliness. The values of GCA effects of the *hirsutum* genotypes for growth characters showed a tendency either positive or negative towards earliness. Therefore, the crosses involved those parents should have a good chance for introducing improved descendants having a short duration to the first boll.

Estimates of GCA effects at the two populations for yield and its major components are presented in Table (2). The genotypes Tamcot and Wild hirsutum exhibited significantly positive GCA for boll weight and seed index at both populations and significantly negative effects for lint percentage at the F_2 populations. Genotype P6 was significant combiner for NB/p and L% at the two populations. Positive GCA estimates closer to the threshold of their standard error are recorded in the F_1 for G85, Tamcot and P6. The GCA for SCY was in no genotype significant at the F_2. The GCA associated with LCY exhibited significantly positive effects with the *barbadense* genotypes G89 at F_1 and P6 at the F_2 generation. Estimates of effects due to GCA and SCA indicated that parental genotypes with higher mean performance had greater GCA. However, cross combinations between best treat yielder were not necessarily high yielder. On the over all basis, the F_2 results tends to show the distinctness of the genotypes G85, P6 and Tamcot as they showed significant desirable GCA for more than half of growth, earliness and yield traits. Such genotypes could be involved in a crossing program to improve growth traits for mechanical harvest. It could be concluded that the introduced genotype Tamcot from *hirsutum* and P6 from *barbadense* were considered as good combiners when breeding is aimed at earliness and yield characteristics. Abo El Zahab (1973) reported significant GCA for earliness in a diallel cross between Egyptian cottons which partially was in accordance with the results obtained herein. The yield variables results were more or less in harmony with those obtained by Abo-El-Zahab and Metwaly (1979).

SCA effects

Estimates of SCA effects of the performance of the exploited populations for growth, earliness and yield variables are calculated and provided by Table (3). Results revealed that at the F_1 population the crosses P6XTamcot and G85XTamcot (both representing low *tallest* X high *lowest* GCA) were significantly shorter than the others, while the crosses P6XTamcot and G89XTamcot behaved the same with the F_2 population. With regard to number of fruiting branches, the crosses P6XG85, G85XTamcot, P6Xwild exhibited significant positive specific combining ability at the first generation, while the crosses P6Xwild and G85XTamcot were significant at F2; these two crosses represent high X low significant positive GCA. The effects of SCA for the node number of first branch NFFB were negatively significant only with the crosses P6XG85 at the F_1 and P6XTamcot at the F_2 population.

With NFFB, the crosses like G85XTamcot and P6XG85 at F_2 were short and closer to the relevant slandered error level. Godoy and Palomo (1999) considered NFFB as a good indicator for earliness, since it can be easily identified and independent of complications arising from shedding of fruit forms. Estimates of SCA effects involving F_1 and F_2 populations for earliness parameters are presented in Table (3). The intraspecific cross G89XG85 and P6XG85 and the intraspecific cross G85XTamcot exhibited significant negative SCA effects for DFF at F_1 generation. Although negative SCA associated with most crosses at F_2, unexpectedly, none of the crosses passes the significance levels presented in Table (4) with the F_2 population. Regarding DFB, the scene

Table 3. SCA effects for growth, earliness and yield variables of cotton hybrids

Traits ●	F_1 crosses									
	G89XP6	G89XG85	G89XWild	G89XTam	P6XG85	P6XWild	P6XTam	G85XWild	G85XTam	WildXTam
PH	-0.03	0.19	3.01	-1.22	0.96	-2.02	-6.24*	1.40	-3.81*	0.14
NFB	0.69	1.06	-3.56*	-0.43	1.14*	2.61*	-2.09*	-0.33	1.30*	2.02*
NFFB	0.15	0.09	-0.42	0.26	-1.02*	-0.24	-0.43*	-0.31	-0.41	0.38
DFF	-0.06	-0.82*	0.07	-0.64	-1.04*	-0.42	0.00	0.50	-0.87*	0.08
DFB	0.45	-2.06*	-0.15	-0.69	0.03	0.84	0.08	-0.33	-0.83	0.70
BP	0.53	0.09	-0.08	0.55	-0.06	1.05	-0.33	0.11	0.01	-0.29
EI	0.03	0.00	0.14	-0.06	1.49*	0.74	-0.05	0.88	2.08*	-1.20*
NB/P	1.45	-1.15	1.25	-0.04	-0.36	1.50	2.00	1.93	2.14	-0.01
BW	0.20	-0.09	0.18	-0.14	-0.01	0.25	0.00	0.04	0.26	-0.15
SI	0.07	0.09	1.56*	-0.75	-0.08	0.90	1.56*	0.88*	-0.75	0.03
L%	0.13	-0.20	-0.02	0.14	1.05	0.83	-0.60	-1.38	0.01	-1.02
SCY	0.39	6.26	0.94	-8.02	-0.19	6.09	5.75	2.03	6.17	-5.03
LCY	1.34	2.68	1.21	-2.96	-0.03	1.54	-1.03	-1.63	2.50	-1.13
Traits ●	F_2 crosses									
	G89XP6	G89XG85	G89XWild	G89XTam	P6XG85	P6XWild	P6XTam	G85XWild	G85XTam	WildXTam
PH	-3.13	5.02	-2.20	-6.90*	-1.03	0.01	-8.19*	-1.01	0.08	0.06
NFB	0.56	0.04	-0.09	-0.13	0.67	1.11*	0.09	-0.50	0.81*	0.33
NFFB	-0.20	0.06	-0.27*	0.04	-0.19	0.06	-1.00*	-0.01	0.37*	0.08
DFF	-0.11	-0.99	0.04	-0.59	-0.80	-0.14	-0.30	-0.50	-0.66	-0.40
DFB	0.36	-0.95*	-1.09*	0.41	-0.50	1.00*	-0.52	0.23	-0.45	0.61
BP	0.08	0.37	0.41	-0.16	-0.09	0.23	-0.45*	-0.03	0.02	-0.43
EI	-1.09	0.81*	0.03	0.28	0.00	0.63	1.94*	-0.27	1.55*	0.12
NB/P	1.50	-0.14	1.53	-1.00	-4.08*	0.01	1.20	-0.62	1.49	1.03
BW	0.13	0.17	1.03*	0.19	-0.01	-1.02*	1.64*	0.09	0.19	0.00
SI	0.09	0.02	0.67*	-3.47*	-0.54	0.66*	0.84*	-0.06	0.32	0.01
L%	1.43	2.77*	-1.00	-2.87*	0.07	1.63	0.94	-1.54	2.59*	-1.04
SCY	3.00	5.31	-0.02	4.82	-1.20	4.11	0.88	-1.01	4.25	-6.75
LCY	1.01	0.26	-0.46	-0.58	-0.67	2.40	1.73	1.05	-0.58	0.20

● Plant height (PH cm), Number of fruiting branches (NFB), the node number of first fruiting Branch (NFFB),Date of first flower (DFF day), Date of first open boll (DFB day), boll period (BP day), earliness index (EI), number of harvested bolls per plant (NB/p), seed cotton yield per plant (SCY/p) and lint cotton yield per plant (LCY/p). * Significant at 0.05 level of probability.

changed little where the crosses G89XWild and G89XG85 were negatively significant at the F_2 population. Crosses P6XG85 and G85XTamcot at F_1 and crosses P6XTamcot and G85XTamcot at F_2 were significantly earlier in SCA than the others with the yield related earliness trait EI. Genotypes P6 and Tamcot were higher and significant general combiner with EI too. The effects of SCA involving the two populations' performance for yield and its attributing variables are given in Table (3). The crosses G89XWild, P6XTamcot, and G85XTamcot showed significant positive SCA with SI at F_1 population. The results associated with NP/p, BW, L%, LCY, and SCY in no case at F_1 indicated significant SCA. Little changes recorded at the F_2; the cross P6XG85 G89XWild and P6XTamcot with BW, G89Xwild, P6XWild and P6XTamcot with SI, G89XG85 and G85XTamcot with L% were significantly positive. The characters SCY and LCY in no cross were significant at the F_2 population. In general, the effect of the generation on the SCA effects revealed some slight significant variation based on the character studied and designated cross. Regarding the effect of generation on the SCA for earliness traits in the studied crosses, the results indicated that the effect of SCA towards earliness were more pronounced at the F_2 population in some crosses such

Table 4. Variances partitioning estimates, genetic parameters and Standard errors of F_1 and F_2 in respect to growth, earliness and yield variables in cotton

	F_1										
	Variances partitioning[⊖]						Standard errors[⊖]				
Trait[•]	σ^2_g	σ^2_s	σ^2_e	σ^2_A	σ^2_D	g_i	S_{gi}	g_i-g_j	S_{ij}	$S_{ij}-S_{ik}$	$S_{ij}-S_{kl}$
DFF	0.48	2.63	1.25	0.95	2.63	0.38	0.98	0.60	0.77	1.04	1.46
DFB	0.92	4.98	2.11	1.83	4.98	0.49	1.27	0.78	1.00	1.34	1.90
BP	0.41	-0.07	1.67	0.81	-0.07	0.07	1.13	0.69	0.89	1.20	1.69
NFFB	0.12	-0.02	0.52	0.25	-0.02	0.24	0.63	0.39	0.50	0.67	0.94
EI	-0.17	5.59	2.50	-0.35	5.59	0.53	1.38	0.85	1.09	1.46	2.07
NFB	0.21	10.13	3.47	0.43	10.13	0.63	1.63	1.00	1.28	1.72	2.44
PH	43.82	176.72	33.37	87.63	176.72	1.95	5.04	3.09	3.99	5.35	7.56
BN/P	-1.43	22.47	7.68	-2.87	22.47	0.94	2.42	1.48	1.91	2.57	3.63
BW	0.06	0.35	0.22	0.13	0.35	0.16	0.41	0.25	0.32	0.43	0.61
L%	4.78	2.31	5.15	9.56	2.31	0.77	1.98	1.21	1.57	2.10	2.97
SI	0.09	3.17	1.48	0.17	3.17	0.41	1.06	0.65	0.84	1.13	1.59
SCY	47.58	176.88	174.12	95.17	176.88	4.46	11.52	7.05	9.11	12.22	17.28
LCY	-0.16	154.69	35.63	-0.31	154.69	2.02	5.21	3.19	4.12	5.53	7.82
	F_2										
	Variances partitioning						Standard errors				
Trait[•]	σ^2_g	σ^2_s	σ^2_e	σ^2_A	σ^2_D	g_i	S_{gi}	g_i-g_j	S_{ij}	$S_{ij}-S_{ik}$	$S_{ij}-S_{kl}$
DFF	1.093	1.16	0.89	2.186	1.16	0.32	0.82	0.50	0.65	0.87	1.24
DFB	0.864	1.45	0.93	1.729	1.45	0.33	0.84	0.52	0.67	0.89	1.26
BP	0.129	0.4	0.85	0.257	0.4	0.31	0.80	0.49	0.64	0.85	1.21
NFFB	0.056	0.02	0.16	0.111	0.02	0.14	0.35	0.21	0.28	0.37	0.52
EI	-0.59	5.58	2.07	-1.19	5.58	0.49	1.26	0.77	0.99	1.33	1.88
NFB	0.226	3.95	2.05	0.451	3.95	0.48	1.25	0.77	0.99	1.33	1.87
PH	25.42	140.8	95.413	50.83	140.8	3.30	8.53	5.22	6.74	9.04	12.79
BN/P	-2.37	29.08	9.65	-4.74	29.08	1.05	2.71	1.66	2.14	2.88	4.07
BW	0.031	0.19	0.15	0.063	0.19	0.13	0.34	0.21	0.27	0.36	0.51
L%	3.709	2.613	10.15	7.418	2.613	1.08	2.78	1.70	2.20	2.95	4.17
SI	0.181	0.28	0.75	0.363	0.28	0.29	0.76	0.46	0.60	0.80	1.13
SCY	-8.41	295	110.47	-16.8	295	3.55	9.17	5.62	7.25	9.73	13.76
LCY	-1.08	132.2	42.84	-2.16	132.2	2.21	5.71	3.50	4.52	6.06	8.57

• Plant height (PH cm), Number of fruiting branches (NFB), the node number of first fruiting Branch (NFFB),Date of first flower (DFF day), Date of first open boll (DFB day), boll period (BP day), earliness index (EI), number of harvested bolls per plant (NB/p), seed cotton yield per plant (SCY/p) and lint cotton yield per plant (LCY/p). ⊖ σ^2_g, σ2s, σ2e, σ2A, and σ^2_D are estimated variances due to GCA, SCA, , environmental error estimate, additive variance, and dominance. SE (Gi) = standard error for any GCA effect. SE (Gi- Gj) = standard error of difference between any two GCA effect. *, * * Significant at 0.05 and 0.01 levels of probability.

as G89X P6, G85 X P6 and G85X Tamcot. The interspecific cross P6XTamcot proved to passes significant positive SCA for NB/P at the F_1 and seed index at the two generations. High combiners for earliness showed negative SCA effects towards lateness. The results recorded are in accordance with the findings of Baker and Verhalen (1975) who observed relatively high levels of SCA effects for earliness in certain crosses.

The results of relevant standard errors and partitioning the genetic variance into its two components additive and dominance variances for all characters and generations are presented in Table (4).

The data could be concluded to that the most of the phenotypic variances of all the studied characters were due to the genetic variance with the exception of the NFFB at the F_1 population, indicating that there was a capability for improving these characters by selection in the early generations. NFFB and NFB are essential to develop varieties studied for mechanical management especially with picking. If we consider the negative estimates of variance as zero, the obtained results indicated that these traits showed a relatively high additive variance and various dominance levels at the two populations indicating the selection for these characters may be efficient in these early generations. Results in table (4) indicated that the characters BP and NFFB exhibited high additive variance at F_1 population, whereas the characters DFF, DFB and NFFB exhibited high additive with the F_2 population. The dominance variances were larger for the other earliness and growth characters. Moreover, the partitioning of genetic variance gave negative estimates of additive variance for earliness index at the tow generations that may considered as zero. In this respect Abo- El-Zahab and Metwaly (1979) found both additive and non additive effects influenced sympodia per plant. The results of break down the genetic variation of yield characters presented in Table (4) revealed that most of the phenotypic variances of all the yield characters were due to the genetic variances. Moreover, the most of the genetic variances was due to additive part of gene effects for the L% at the two generations, indicating the possibility for practicing selection targeted to improve these characters at early segregates. SI exhibited high additive variances comparable with the dominance variance at F_1 generation; this trend was reduced at the F_2 population. The splitting of the genetic variances gave negative estimates of NB/p, LCY/p and SCY/p (F_2 only), that may consider as zero. The traits like NB/p, BW, SCY/p and SCY/p proved to have relatively small additive variances than dominance; the well designed hybridization programmes could be exploited to improve these characters. Similar results were obtained by Abo El-Zahab and Metwaly (1979), Singh and Singh (1981).

DISCUSSION AND IMPLICATION

The present paper gives estimates of combining ability effects for cotton growth, earliness and yield variables. The estimates of additive and dominance variances are valuable guides for choosing the most appropriate breeding procedures for improving certain population (Mather, 1971). The review of literatures tends to imply that the estimations of additive effects provide information relevant to early generation selection in the development of pure lines, while the magnitudes of dominance effects are important in the development of hybrids. Variance component analysis reported herein indicated that the studied traits exhibited significant additive and non-additive variation in their expression since both GCA and SCA were significant. Moreover, GCA effect for the five parents varied significantly for growth, earliness and yield, in addition to between generations. The genotype G85 from Egyptian category was the best overall general combiner; it showed positive GCA effects for the majority of the studied traits. Besides, it combined well with the selected U.S. cultivars chosen for this study i.e., P6, Tamcot and Wild strain. Thus, it would be a good source of parental germplasm for improving traits like NFFB, NFB, and EI. Equally likely was the genotype P6 that passes G85 with DFB and plant height. But none of them interacted significantly with other earliness growth-based traits. The Tamcot and Wild accession were good general combiners for the majority of growth and yield components especially boll weight. SCY and LCY tended to increase when these parents were used. Tamcot SP and wild accession can be used as donor parents to provide short PH, DFF and DFB genes and then backcrossing such earliness carriers into a high yielding *barbadense* cultivar like G85. Although G89 has a distinct fiber quality (Abdalla 2006) it did not exhibit GCA effects as great as the other *barbadense* lines. Egyptian cotton breeders could benefit from using P6 and Tamcot to improve specific characters like growth and earliness PH, DFF, BW variables and thus for transferring genes assisting in reconstructing an Egyptian genotype can be mechanically harvested. Selection based on progeny performance may prove useful in cases where additive gene action is predominant compared to non-additive gene action. In case of the presence of both additive and non-additive components are operative, as it seems to happen currently, the study see the appropriate breeding approach would be to isolate the non-additive genes and simultaneously maintaining the degree of heterogeneity for exploiting the additive component.

However, the non-additive gene action that looks controlling the inheritance of some studied traits can be operationally exploited by heterosis breeding. Although succeeded in China and India, heterosis not possible at least at present in Egypt (Abdalla 2007). Thus, breeding methods like recurrent selection and diallel selective mating (Jensen, 1970) may serve well. The number of cases of SCA effects of a line in any particular cross can be defined as the magnitude of the deviation exhibited by that line in the cross from the performance expected of it on the bases of its GCA effects. A significant departure from zero in any one cross would indicate high or low SCA according to the sign whether plus or minus. High SCA effects traditionally mean that there are non additive genetic effects in action. The performance of the hybrids seems to be more realistic for selecting the best cross combination as compared to SCA effects (Table 5). The SCA, being an estimate, is based on certain assumptions; the performance itself and the actual realized mean, Simmonds, 1979. Based on the study results, the comparison of cross combinations based on the two criteria did not indicate reliable correspondence between the two criteria. Consequently, the selection of cotton crosses based on heterotic response may not prove effectively. To exploit such cross in cotton breeding where the pure line breeding is more pronounced than hybrids, it has to show high SCA involve

Table5. Assessment of combinability information on the top three hybrids in relation to the *per se* genotypes' performance

F1						F2					
Char-acter	Genotype	Perfor mance	SCA	GCA Status°		Char-acter	Genotype	Perfor-mance	SCA	GCA Status°	
				P_1	P_2					P_1	P_2
PH	G85XWild	71.88	1.40	2.05L*	-4.30H*	PH	P6XTamcot	71.06	-8.19*	3.14L	3.87H*
	G89XP6	79.12	-0.03	2.98L*	1.02H		P6XWild	80.65	0.01	3.14L	6.49H*
	P6XTamcot	80.50	-6.24*	1.02L	1.29H		G89XWild	80.98	-2.20	3.98L*	6.49H*
NFB	G89XG85	14.83	1.06	0.34H	1.65H*	NFB	G89XG85	13.77	0.04	0.36L	1.11L
	P6XTamcot	14.33	-2.09*	3.13H*	-0.39		G85XWild	13.10	-0.50	1.11H*	-0.20L
	G85XWild	13.94	-0.33	1.65H*	-1.02*		G85XTamcot	12.09	0.81*	1.11H*	-1.03L*
NFFB	G85XTamcot	4.20	-0.41	0.06L	-0.25H*	NFFB	P6XG85	4.34	-0.19	0.04L	0.15L*
	G85XWild	4.14	-0.31	0.06L	-0.61H*		P6XWild	4.11	0.06	0.04L	0.18H*
	G89XTamcot	4.09	-0.42	0.08L	-0.25H*		G85XWild	4.10	-0.01	0.15L*	0.18H*
DFF	P6XWild	62.10	-0.42	-0.31L	-0.53H*	DFF	G85XWild	62.43	-0.50	0.03L	0.47H*
	G85XWild	65.20	0.50	-0.04L	-0.53H*		G85XTamcot	65.22	0.67*	0.03L	0.46H*
	G89XTamcot	65.87	-0.64	0.01L	-0.41H*		P6XWild	67.84	-0.14	-0.98L*	0.47H*
DFB	P6XWild	110.43	0.84	-0.24L	-0.50H*	DFB	G85XWild	107.21	0.23	-0.12L	0.34H*
	P6XTamcot	111.57	0.08	-0.24L	-0.48H*		G85XTamcot	108.00	-0.45	-0.12L	0.39H*
	G85XWild	112.00	-0.33	0.12L	-0.50H*		P6XWild	112.30	1.00*	-0.27L	0.34H*
BP	P6XG85	41.65	-0.06	0.13H	0.12H	BP	G85XTamcot	42.78	0.02	1.12H	0.15L
	G89XG85	42.47	0.09	0.16H	0.12H		G89XTamcot	43.87	-0.16	1.05H	0.15L
	P6XTamcot	44.37	-0.33	0.13H	-0.30L		P6XTamcot	44.14	-0.45*	0.10H	0.15L
EI	G85XWild	89.20	0.88	-0.06L	2.04 H*	EI	G85XWild	79.91	-0.27	0.59L*	1.93H*
	G85XTamcot	77.30	2.08*	-0.06L	0.92H*		G85XTamcot	77.30	1.55*	0.59L*	0.57H*
	G89XTamcot	76.00	-0.06	0.65L*	0.92 H*		G89XTamcot	77.01	0.28	-2.00L*	0.57H*
NB/P	G89XP6	24.30	1.45	1.05H	1.30 H*	NB/P	G85XTamcot	21.64	-0.62	-0.94L	0.26L
	G89XWild	23.01	1.25	1.05H	-1.01 L		G89XTamcot	21.50	-1.00	0.89H	0.26L
	P6XG85	23.00	-0.36	1.30H*	-0.08 L		G89XG85	21.47	-0.14	0.89H	-0.94L
BW/g	G85XWild	3.59	0.04	0.14L	0.34H*	BW/g	G85XWild	3.64	0.09	0.15L*	0.60H*
	P6XWild	3.50	0.25	-0.11L	0.34H*		P6XTamcot	3.57	1.64*	-0.40L*	0.19H*
	G89XTamcot	3.41	-0.14	0.08L	0.26H*		G89XWild	3.54	1.03*	0.12L	0.60H*
L%	G89XG85	40.99	-0.20	0.94H*	0.72L	L%	P6XG85	40.67	0.07	2.04H*	1.02H*
	G89XP6	39.77	0.13	0.94H*	2.25H*		G89XP6	40.10	1.43	0.99H	2.04H*
	P6XG85	39.77	1.05	2.25H*	0.72H		G89XG85	39.04	2.77*	0.99H	1.02H*
SI	G85XTamcot	12.18	-0.75	0.76L*	1.06H*	SI	P6XTamcot	11.68	0.84	-0.43L	0.81H*
	G89XWild	11.58	1.56*	-0.31L	1.94H*		G89XTamcot	11.40	-3.47	-0.10L	0.81H*
	P6XWild	11.45	0.90	-0.26L	1.94H*		P6XWild	11.15	0.66	-0.43L	2.02H*
SCY	P6XTamcot	75.90	5.75	3.04L	2.49L	SCY	G85XTamcot	77.65	4.25	1.97L	1.44H
	G85XTamcot	71.46	6.17	4.38H*	2.49L		P6XTamcot	72.84	0.88	-1.37L	1.44H
	P6XG85	65.33	-0.19	3.04L	4.38 H*		G89XWild	60.72	-0.02	-1.70L	1.95H
LCY	P6XTamcot	26.01	-1.03	-0.03L	0.09L	LCY	P6XTamcot	25.00	1.73	2.32H*	0.56H
	G89XG85	25.08	2.68	2.13H*	1.09L		G85XTamcot	23.06	-0.58	0.34L	0.55H
	G85XWild	23.18	-1.63	1.09L	1.03L		G89XWild	22.67	-0.46	1.94L	1.66H

⊖ Plant height (PH cm), Number of fruiting branches (NFB), the node number of first fruiting Branch (NFFB),Date of first flower (DFF day), Date of first open boll (DFB day), boll period (BP day), earliness index (EI), number of harvested bolls per plant (NB/p), seed cotton yield per plant (SCY/p) and lint cotton yield per plant (LCY/p). ⌂ H and L: indicate 'high' and 'low' GCA effect.

both the parents which are also good general combiners. Since this was not common in the current study, the theory of high X low method proposed by Langham (1961) can be discussed as follow: consider the significant GCA for a particular character in the desire direction (for example negative with plant height) as high (H) and non-significant or significant in the other direction as low (L), the crosses recorded high mean performance (carry out in the top three out of the ten crosses) associated with their SCA and GCA

status of each of the two contributed parents could be identified for each character of the three studied categories (Table 5). It can be concluded from the table that crosses P6XG85, P6XG85, P6XTamcot appeared to be promising; it performed well with respect to growth, earliness and yield especially at the F_2 population. The investigator can also select crosses for improving either a set of character or an individual one. Finally, taking into consideration that the genotype fitted to mechanical harvesting should be shorter than Egyptian genotypes and low in NFFB that is reflected in compacted flowering zone. In addition, it should be practically earlier with DFF, DFB, and high yielding capacity. The study tends to recommend the varieties G85, P6, Tamcot and their dependent filial generation to start selection program towards an Egyptian plant type can be picked by machine.

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الهجن بين وداخل أنواع القطن
٢- تقدير التباينات والقدرات علي التوافق لهجن الجيلين الأول والثاني لصفات النمو والتبكير والمحصول ومكوناته

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استخدمت الدراسة طرز القطن الأمريكي المحتواة علي وفرة وراثية في جينات المواءمة للجني الميكانيكي. باستخدام التهجين بتصميم الداي أليل المستقيم لخمسة سلالات قطنية تم تقدير التباينات وتأثيرات القدرات علي التآلف لصفات النمو والتبكير والمحصول ومكوناته لبيانات تم جمعها من مجتمعات الأجيال الأول والثاني. كما استهدفت الدراسة أيضا تحديد طبيعة توارث تلك المتغيرات والتي تلعب دورا في تحديد طريقة التربية لغرض الدراسة. التجارب الحقلية للآباء والأجيال تمت بمزرعة كلية الزراعة- جامعة القاهرة في صيف 2004- 2006. أوضحت النتائج أن طبيعة فعل الجين غير المضيف يحكم لصفات معامل التبكير وعدد اللوز بالنبات ومحصول القطن الشعر بينما كان الفعل المضيف يحكم باقي الصفات. القدرة العامة علي التآلف اختلفت معنويا بين الأصناف والأجيال. سلالات الصنف المصري جيزة 85 كان أفضل السلالات قدرة عامة علي التآلف حيث كانت تأثيرات GCA موجبة لأغلب الصفات. بالإضافة لإتحاده الجيد مع الطرز الأمريكية PS-6 و

Tamcot لتحسين صفات مثل ارتفاع عقدة أول فرع ثمري وعدد الأفرع الثمرية وكذلك معامل التبكير. الطرز Tamcot و Wild أظهرت قدرة عامة علي التآلف جيدة لصفات النمو والمحصول وخصوصا وزن اللوزة. هذان السلالتان أيضا مصدر جيد للإمداد بجينات قصر النبات وتقليل الفترة من الزراعة وحتي أول زهرة وأول لوزة. تميل الدراسة إلي التوصية بالأصناف جيزة 85 و بيما 6 و تامكوت وأجيالها الانعزالية لبدأ برنامج انتخاب موجه لتركيب طراز قطني مصري يناسب الجني آليا.

مجلد المؤتمر الخامس لتربيه النبات – الجيزه ٢٧ مايو ٢٠٠٧
المجلة المصريه لتربية النبات ١١ (٢): ٨١٣-٨٢٧ (عدد خاص)