COMBINING ABILITY FOR CERTAIN AGRONOMIC AND FIBER PROPERTIES IN EGYPTIAN COTTON

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ABSTRACT

Ten agronomic and fiber properties were studied in six cotton parents (Gossypium barbadense, L.) and their hybrid and reciprocal combinations in 1983 at Sakha Experimental Station. Two parents, "Giza 45" and Giza 70" are extralong staple cultivars and the other four viz, "Giza 75, Giza 69, Giza 67 and Giza 66" belong to the long-staple group. The two extra-long cultivars yield less than their long-staple counterparts, however they enjoy the advantage of producing longer, finer and stronger fibers. Our aim was to evaluate the six parental cultivars for GCA and SCA effects and to investigate the possibility of combining the high yield of the long group with better fiber qualities of the extra-long group.

Significant general combining ability (GCA) estimates for seedcotton yield/plant (SCY) and boll weight in favorable direction were detected for Giza 75. And significant GCA effects for fiber properties, in favorable direction was detected in Giza 45 and Giza 70. These significant GCA effects suggested the feasibility of transfering higher yield from Giza 75 to Giza 45 and Giza 70 and incorporating the better fiber qualities of the latters to Giza 75. However, specific combining ability effects are frequent in fiber properties, which might pose formidable breeding problems.

Significant reciprocal effects were detected for seed index, lint index and the five fiber characteristics. Those reciprocal effects pertaining to seed index and lint index were few and probably of little consequence. However, those related to fiber properties are abundant and perhaps of some value especially in each of fiber length, fiber fineness and strength.

INTRODUCTION

Some varieties of cotton are endowed with the ability to confer high yield and quality to their progenies; others are not. Because of this, parents chosen for breeding purposes should meet certain prerequistes such that the possibility of combining desirable genes for favorable characers in new genetic recombinations would proceed without much difficulty. Therefore, this investigation was carried out with the aim to determine the breeding merits of some Egyptian cotton varieties.

Determining types of gene actions from cross progenies of a set of parents are made available through the biometrical approaches devised by Jinks (1954), Hayman (1954) and Griffing (1965a). Economic characters of Egyptian cotton were investigated in earlier work of Abo El-Zahab (1973). Findings in Egyptian cotton referred to the importance of GCA for seedcotton yield and lint index, [Abo El-Zahab, (1973); Hassoub, (1974); Abd El-Latif (1975) and El-Adel (1979)]. GCA was reported more important than SCA in the inheritance of boll weight, lint index, seed index and lint percent (Galal, 1972; Hassoub, 1974; El-Emam, 1975; El-Adel et al., 1979 and El-Gohary et al., 1981). However, highly significant SCA effects were reported for seedcotton/plant and lint percent (Selim et al., 1979 and Zaitoon et al., 1982).

This investigation was carried out with the aim to determine types of gene effects and the breeding merits of some cotton varieties.

MATERIALS AND METHODS

Seeds of six parents and 15 F_1's, F_2's combinations and their reciprocals were planted on 21st of April 1983 at Sakha. The parents included the two extra-long cultivars, namely Giza 45 and Giza 70 and the four long staple cultivars, namely, Giza 66, Giza 67, Giza 69 and Giza 75. The whole set of parents, F_1's, F_2's and reciprocals were planted in a randomized complete block design with six replications. Plots were two rows each and the row was 7.5 m long and 60 cm wide. There were ten hills per row spaced 70 cm apart. Hills were thinned to single plants after forty days from planting. All experimental plots were treated likewise through the experimental season.

A representative sample of ten guarded plants from each plot were used to determine seedcotton yield (SCY). Seedcotton yield samples were weighted and the following data were obtained; boll weight (seedcotton/boll, g.) and seed index (100-seed weight, g.) and lint index (LI). The following fiber properties were determined at the Laboratory of Cotton Rsearch Institute of the Agricultural Research Center, Giza; half fall and mean length in 1/32", micronaire, hair weight in millitex and yarn strength in Pressly units.

Data were analyzed as randomized complete block, and traits which showed significant differences among genotypes were further analysed for combining ability by Griffing's (1956b) Model I. (fixed effects) Method I. (parents, hybrids and reciprocals). The analysis was used to estimate general combining ability (GCA) and specific combining ability (SCA) and reciprocal effects.

RESULTS AND DISCUSSION

A- General:

Mean squares for genotypes, GCA, SCA and reciprocals in F_1 and F_2 are given in Table (1) with GCA/SCA ratios. Signifiant or highly significant GCA mean squares were detected for all variables except boll weight in F_2. SCA mean squares showed signifiant or highly significant estimates for lint index, hair weight, staple and Mean lengths and yarn strength in F_1. In F_2, significant or highly significant SCA mean squares were obtained for all variables implying SCA by genotype interaction. Results, also indicate high GCA/SCA ratios for all variables with the exception of mean length in F_1 and boll weight in F_2. Thus additive effects are responsible for most of the genetic variances in all variables under consideration.

Reciprocal mean squares are insignifiacnt for seedcotton yield, boll weight and lint percent in both generations. The magnitude of reciprocal variances is almost lower than GCA variances. Thus, maternal effects in the expression of these variables is assumed very scant. In contrast, significant reciprocal mean squares were obtained for seed and lint indices and all fiber properties with the exception of micronaire. Therefore, results imply the importance of reciprocal effects in the expression of these traits and in particular with fiber properties.

Table (1): Observed mean squares of genotypes, GCA, SCA and reciprocal effects of all variables for F_1 and F_2 populations.

Characters	Genotypes		G.C.A		S.C.A		Reciprocal M.S		G.C.A/S.C.A	
	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2	F_1	F_2
Yield	378.67*	232.90**	189.39**	111.41**	47.37	33.26*	43.79	20.03	2.94 : 1	3.35 : 1
SCY/plant	0.0719**	0.0882*	0.041**	0.0146	0.0076	0.0299**	0.007	0.0098	5.39 : 1	0.49 : 1
Boll/wt.	11.64**	9.77**	10.29**	2.86*	0.451	1.89*	0.5275	0.9258	22.82 : 1	1.51 : 1
Lint %	0.7538**	0.5081**	0.2899**	0.2658**	0.0493	0.1652**	0.0774*	0.1402**	5.88 : 1	1.61 : 1
Seed index	0.8116**	0.5875**	0.6113**	0.3299**	0.0491*	0.2203**	0.0615**	0.1284*	16.53 : 1	1.50 : 1
Lint index										
Fiber Properties	0.2652**	0.2603**	0.443**	0.1743**	0.0187	0.2772**	0.0343	0.087**	23.69 : 1	0.63 : 1
Mic.	1493.81**	1456.19**	2132.63**	1594.62**	234.69**	360.75**	169.30**	278.70**	9.09 : 1	4.42 : 1
Hair wt.	18.88**	20.83**	14.87**	24.12**	4.44**	5.12**	5.93**	5.30**	3.35 : 1	4.71 : 1
Staple length	0.0055**	0.0064**	0.0003**	0.0042**	0.0007**	0.0011**	0.0009**	0.0013**	0.43 : 1	3.82 : 1
Mean length										
Yarn strength	124061.97**	154398.75**	148951.40**	68404.68**	39542.28**	47746.31**	17690.20**	98563.05**	3.77 : 1	1.43 : 1

*, ** Significant at 0.05 and 0.01 levels, respectively.

B- Seedcotton yield and lint components:

With reference to table 2, data show clearly that Giza 75 yielded more SCY/plant, heavier bolls and higher seed and lint indices than the rest of the cultivars and compared favorably with Giza 69 in most of the agronomic traits except lint percent. The latter exceeded Giza 75 in this respect. Other cultivars, namely Giza 70, Giza 66 and Giza 67 compared favorably in one or more of the organomic traits, (Table 2). Giza 45 and Giza 70 were comparable in many aspects but manifested the lowest performance in the traits under consideration.

Results of GCA showed that Giza 75 was the only cultivar with significant favorable GCA effect for SCA/plant, boll weight and lint index. Thus, one possible way to upgrade the yielding capacity of the extra-long group, i.e., Giza 45 and Giza 70 cultivars could be achieved through hybridization with Giza 75. Giza 69 manifested the highest lint percentage coupled with the most favourable GCA effect for the trait (Table 2). This would suggest another vesta to improve yield of the extra-long group through crossing with Giza 69 cultivar.

Other parent as suggested by the data are more or less poor combiners either because of low GCA estimates or inconsistency of estimates over the F_1 and F_2 generations.

The summary of the SCA effects (Table 4) showed that two only of the seventy five character hybrid/combinations showed significant SCA effects in F_1. These two deviations are for lint yield, one each for hybrids 3 and 10. Both hydrids has Giza 67 in their pedigrees. A few number of hybrids showed significant SCA effects for yield components in F_2. Out of the seventy five possible character hybrid/combinations, thirteen were observed. Two of the deviation are for boll weight in unfavorable direction and occurred in hybrids 9 and 14. One deviation is for lint per cent and is represented by hybrid 14 and in unfavorable direction. Six deviation, nearly one half of the total deviation occurred in seed index only. One deviation is toward increasing this trait and occurred in hybrid 3 and the rest five are negative deviations, one each for hybrids 7, 8, 11, 14 and 15. The last three deviations are for lint index; one each for hybrids 3, 7 and 14 and the last two are in favorable direction.

Table (2): Seedcotton and lint yield components, and GCA estimates for six Egyptian cotton cultivars.

Parents	SCY/ Plant	Boll wt.	Seed index	Lint index	Lint %
		gm.		%	
Means					
Giza 45	34.1 c	2.32 c	9.47 b	4.10 d	30.18 d
Giza 70	48.1 b	2.67 b	9.60 b	5.13 c	34.80 c
Giza 66	51.2 ab	2.72 ab	10.34 a	5.55 b	34.90 c
Giza 67	45.6 b	2.67 b	9.95 ab	5.57 b	35.75 b
Giza 69	48.7 b	2.72 ab	10.14 a	5.97 a	37.04 a
Giza 75	59.8 a	2.85 a	10.29 a	5.66 a	35.48 b

GCA effects	F1	F2	F1	F2	F1	F2	F1	F2	F1	F2
Giza 45	-6.53**	-4.61**	-0.09**	--	-0.07	-0.11	-0.35**	-0.12*	-1.45**	-0.75**
Giza 70	0.50	1.01	-0.04	--	-0.23**	-0.24**	-0.21**	-0.23	-0.53**	-0.27
Giza 66	1.29	-1.39	0.03	--	-0.11*	0.14*	0.06	0.19	0.04	0.39
Giza 67	0.24	-0.24	0.05**	--	0.19**	0.06	0.15**	0.13**	0.33*	0.24
Giza 69	0.93	0.56	-0.53**	--	-0.20**	0.15**	0.23**	0.10	1.29	0.56*
Giza 75	3.56*	4.67**	0.12**	--	0.10*	0.00	0.12**	-0.07	0.35*	0.18
Standard errors										
GCA effects:	0.59	0.42	0.007	--	0.005	0.07	0.02	0.01	0.01	0.01
GCA-diff. bet. parents	0.91	0.66	0.011	--	0.08	0.11	0.03	0.02	0.02	0.02

* GCA effect significant (t=1.993; 72 df) at the 0.05 level of probability.
** GCA effect significant (t=2.575; 72 df) at the 0.01 level of probability.

Table (3): Fiber properties and GCA estimates of Six Egyptian cotton cultivars.

Parents	Mic.	Hair wt.	Staple length	Mean length	Yarn strength
Means					
Giza 45	3.1 b	127.33 d	46 b	0.98 ab	2717 a
Giza 70	3.8 a	140.67 c	47 ab	1.02 b	2515 b
Giza 66	4.0 a	207.33 a	41 c	0.92 c	1900 d
Giza 67	4.1 a	206.00 a	41 c	0.93 c	2118 c
Giza 69	3.9 a	186.00 b	41 c	0.93 c	2140 c
Giza 75	4.2 a	204.33 a	48 a	0.92 c	2223 c

GCA effects	Mic. F1	Mic. F2	Hair wt. F1	Hair wt. F2	Staple length F1	Staple length F2	Mean length F1	Mean length F2	Yarn strength F1	Yarn strength F2
Giza 45	-0.32**	-0.18**	-20.47**	-16.89**	-0.08	0.19	-0.001	0.003	161.81**	45.75*
Giza 70	0.11**	-0.12**	9.31**	-10.06**	1.33**	0.94**	0.023**	0.020**	66.31**	106.83**
Giza 66	-0.02	0.13**	5.87**	11.11**	-1.00**	-1.33**	0.013**	0.018**	55.69*	-83.58**
Giza 67	0.03	0.06	6.30**	6.11**	-0.75*	-1.06**	-0.012**	0.001	-158.86**	-72.92**
Giza 69	0.05	0.02	0.28	-1.06	-0.92**	-1.06**	-0.011**	-0.013**	-45.86	32.33
Giza 75	0.28**	0.08*	17.69**	10.78**	1.42**	2.28**	0.014**	0.024**	32.31	27.25
Standard errors										
GCA effects	0.009	0.009	0.40	0.43	0.08	0.05	0.001	0.001	6.44	6.16
GCA-diff. bet. parents	0.015	0.014	0.62	0.67	0.13	0.08	0.002	0.002	9.98	9.54

* GCA effect significant (t=2.031; 36 df) at the 0.05 level of probability.
** GCA effect significant (t=2.605; 36 df) at the 0.01 level of probability.

Table (4): Number of yield compoenents and fiber properties with significant SCA effects in cotton hybrid combinations, F_1 and F_2.

No.	Hybrid	Characters with signifiant SCA Effects++			
		Yield Components		Fiber Properties	
		F_1	F_2	F_1	F_2
		no.			
1	Giza 45 x Giza 70	--	0	4	2
2	Giza 45 x Giza 66	--	-	0	1
3	Giza 45 x Giza 67	1	2	1	2
4	Giza 45 x Giza 69	--	1	2	3
5	Giza 45 x Giza 75	--	0	1	1
6	Giza 70 x Giza 66	--	0	3	3
7	Giza 70 x Giza 67	--	1	1	4
8	Giza 70 x Giza 69	--	1	1	2
9	Giza 70 x Giza 75	--	1	3	5
10	Giza 66 x Giza 67	1	0	3	3
11	Giza 66 x Giza 69	--	0	1	1
12	Giza 66 x Giza 75	--	1	1	3
13	Giza 67 x Giza 69	--	1	1	1
14	Giza 67 x Giza 75	--	4	2	5
15	Giza 69 x Giza 75	--	1	2	2

++ 5 character possible in each generation/hybrid combination.
-- Uncalculated values because of nonsignificant Osi.

Table (5): Number of yield components with significant reciprocal effects in cotton hybrid combinations.

No.	Hybrid	Characters with SCA Effects++			
		Yield Components		Fiber Properties	
		F_1	F_2	E_1	E_2
		no.			
1	Giza 45 x Giza 70	0	0	3	1
2	Giza 45 x Giza 66	0	0	2	1
3	Giza 45 x Giza 67	2	1	2	2
4	Giza 45 x Giza 69	0	1	2	1
5	Giza 45 x Giza 75	0	1	3	2
6	Giza 70 x Giza 66	0	2	2	4
7	Giza 70 x Giza 67	0	0	2	1
8	Giza 70 x Giza 69	0	0	2	3
9	Giza 70 x Giza 75	2	0	3	3
10	Giza 66 x Giza 67	1	0	0	1
11	Giza 66 x Giza 69	0	0	2	4
12	Giza 66 x Giza 75	2	0	3	4
13	Giza 67 x Giza 69	0	1	3	4
14	Giza 67 x Giza 75	0	0	3	3
15	Giza 69 x Giza 75	0	1	3	3

++ 5 character possible in each generation/hybrid combinatic

C- Fiber properties:

GCA estimates of the six parents pertaining to fiber properties are shown in Table (3). Estimates for micronaire, hair weight and fiber length showed almost consistent results in F_1 and F_2. Giza 66 and Giza 75 exhibited significant values toward coarses fibers, but Giza 45 and Giza 70 showed significant values toward finer fibers. Giza 67 is a good combiner for micronaire and Giza 69 is a poor combiner for fiber fineness.

For fiber length, results showed that Giza 75 and Giza 70 exhibited high significant positive GCA effects in both F_1 and F_2. Giza 66, Giza 67 and Giza 69 gave highly unfavorable GCA for both staple length and mean length. Thus, Giza 70 and Giza 75 are good combiners, whereas Giza 45 is a poor combiner.

With regard to yarn strength. Giza 45 and Giza 70 are good combiners for yarn strength. The rest of parents are poor combiners for the trait.

SCA effects (Table 3) showed that all hybrids manifested signifiant SCA effect. Among the six parents SCA was significant for 27 of 75 possible characters hybrid/combinations in F_1. Six of the 27 deviations were for hair weight and occuring in hybrids 1, 5, 10, 11, 12 and 14. 10 SCA deviations were for mean length and occuring in hybrids 1, 3, 4, 5, 6, 7, 9, 10, 14 and 15. The remaining 5 deviations were for yarn strength and occuring in hybrids 1, 4, 6, 8 and 9 all characters.

Reciprocal effects were significant for the two characters seed index and lint index. Four of the 15 F_1 combinations showed reciprocal differences in at least one of the two cahracters. And, four of the 15 F_2 combinations showed significant reciprocal differences in at least one of the two characters. Only hybrid number 3 showed consistent reciprocal effects for seed index from amongest the eight hybrids showing reciprocal effects, Table (5). The inconsistancy of reciprocal effects in these two characters makes the resuts far from being irresolute. In F_2, there were 12 extra SCA deviations in addition to the six deviations pertaining to micronaire. These extra 12 deviations were distributed as follows; four for hair weight and occuring in hybrids 6, 7, 8 and 14; five for staple length occuring in hybrids 3, 4, 7, 8 and 12; the last three were for yarn strength and occuring in hybrids 3, 5 and 14. There was at least one SCA deviation for each hybrid in each F_1 and one in F_2. Hybrids with frequent deviations were those having Giza 70 parent in their pedigrees.

As to reciprocal effects, all hybrids showed at least one deviation in any one of the five fiber properties. Because of their unstability over F_1 and F_2, it is difficult to tell wether these deviations are real or just due to environmental effects on some hybrid combinations.

D- Breeding implications:

Our results are in good conformity with those previously reported by Abo El-Zahab (1973); Abd El-Latif (1975) and El-Adel et al. (1979), who referred to the importance of GCA in the inheritance of seedcotton yield and lint index. And agreed with those reported by Galal (1972), Hassoub (1974); El-Adel et al. (1974); El-Emam (1975) and El-Gohary et al. (1981) who refferred to the importance of GCA over SCA in the inheritance of boll weight, seed index, lint index and lint percent. Findings suggest that selection of parents should be based on their performance and GCA effects to improve yield components. And selection could proceed in early generations without complications.

The GCA effects of Giza 75 in a favorable direction for most of the characters encourage us to belive that these properties could be transfered easily to other cultivars. However, because of, significant SCA with most of fiber properties in hybrids having Giza 75 suggest that breeding problems may be encountered. To illustrate, the significance SCA effect for lower yarn strength in Giza 75 x Giza 45 lessen our ability to predict future yarn strength. So the significance of SCA effect in the hybrid Giza 75 x Giza 70 for lower boll weight, lower staple and mean lengths implicate the same difficulty. It should be worthwhile to attempt to extract segregates from Giza 75 x Giza 45 or Giza 70 hybrid families with enhanced qualifications.

Reciprocal effects are there, yet their results are irresolute and need further investigation to establish their merits.

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القدرة العامة على الائتلاف للصفات المحصولية وصفات الشعر في القطن المصري

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أظهرت نتائج دراسة عشر من الصفات المحصولية وصفات الشعر لستة من أصناف القطن المصري هم :

جـ ٤٥ ،جـ ٧٠ ،جـ ٦٩ ،جـ ٧٦ ،جـ ٦٦ ،جـ ٧٥ وكذا هجنهم والهجن العكسية لهم أظهرت مايلي :-

١ - القدرة العامة على الائتلاف لصفتي محصول القطن / نبات ووزن اللوز ،كانت عالية ، بالنسبة لصنف جـ ٧٥ .

٢ - القدرة العامة على الائتلاف لصفات الشعر كانت عالية بالنسبة لصنفي جـ ٤٥،جـ ٧٠ .

٣ - وبناء عليه يمكن القول أنه من الممكن تحسين انتاجية صنفي جـ ٤٥ ،جـ ٧٠باستخدام القدرة العامة على الائتلاف العالية لصنف جـ ٤٥ ،جـ ٧٠ الى الصنف جـ ٧٥ .

٤ - القدرة الخاصة على الائتلاف كانت موجودة بالنسبة لصفات الشعر الامر الذى قد يترتب عليه بعض التعقيدات عند التربية لهذه الصفات .

٥ - أظهرت النتائج فروقا بين الهجن والهجن العكسية بالنسبة لصفتي دليل البذرة ودليل التيلة وكل من صفات الشعر المدروسة وكانت الفروق أكثر توافرا بالنسبة لهذه الاخيرة مما يرجح أهميتها .