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VARIATION IN F_2 POPULATION FOR EXTRA LONG X LONG STAPLE CROSSES IN EGYPTIAN COTTON

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ABSTRACT

Successful cotton breeding programs focus initially on developing new genotypes with high yields and improved fiber quality. The main aim of this work was to determine the inheritance of yield and fiber quality of an extra long staple (ELS) variety in two crosses with long staple parents and to determine the variability in F_2 populations. Hybridization between the Egyptian extra-long staple (ELS) cotton variety Giza 88 as a female parent pollinated by the long staple varieties, Giza 86 in cross I and Suvin in cross II in 2014 season. Parents and both F_1 and F_2 generations were grown in a randomized complete block design during 2016 season at Sakha Experimental Station Farm, ARC. Data were recorded on individual plant basis for the studied traits. The studied genotypes, parents and both F_1 and F_2 generations were significantly different for all the studied traits, reflecting the genetic diverse back ground of these parents. The variation due to parents vs. F_2 generation was also highly significant for most of the studied traits. The long staple varieties (Giza 86 and Suvin) had the higher mean performance for yield and its component traits whereas the extra long staple variety (Giza 88) gave the highest values for fiber properties, both F_1 and F_2 were intermediate. F_2 population produced greater yields of seed cotton and lint cotton with heavier bolls and higher lint% as compared to the ELS parent. Whereas, fiber properties for F_2 were not improved over the ELS parent. With regard to the induced variability, F_2 population showed the wider ranges of distribution, higher variance and higher C.Vs as compared with the parents for all traits in the two crosses reflecting the efficiency of artificial hybridization in inducing variability in the studied genotypes. Cross II gave higher variance and C.Vs than cross I for most traits indicating that the introgressed variety Suvin induce more variability when it crossed with the Egyptian variety than the cross between the two Egyptian varieties. Broad-sense heritability (h^2_b) was high for fiber traits than yield and its component traits traits. High h^2_b values were recorded for fiber length in both crosses; moderate values were recorded for lint%; fiber fineness; strength and uniformity. Low values were observed for boll weight, seed index seed cotton and lint yields. Mid-parent heterosis in F_1 populations was low for most traits. Inbreeding depression % showed positive values for most of the studied traits. All traits in both crosses showed partial dominance, the direction was toward the higher parent for most traits. Neither of the F_2 populations in both crosses exceeded the high parental mean for any economical trait (lint yield and fiber quality) although some of F_2 individual plants gave higher yield and/or fiber quality than the parents. The value of these populations likely will be derived from the selected individual plants to be used in a pedigreed breeding program.

Key words: ***Egyptian cotton, extra- long staple, hybridization, variance, F_2 population.***

INTRODUCTION

Successful cotton breeding programs focus initially on developing new genotypes with high yields and also incorporate genes that improve fiber quality. Breeders need to understand how extra long staple (ELS) material should be used in a pedigree breeding program to realize the full benefits of the germplasm. Some breeders made many attempts to use *Gossypium barbadense* L. for improvement of Upland cotton *G. hirsutum* in breeding programs (Lacape *et al* 2005). *G. hirsutum* is characterized by low fiber quality and high yield, whereas *G. barbadense* has superior fiber quality and low yield. The introgression of favorable alleles from *G. barbadense* would likely improve the fiber quality of Upland cotton while simultaneously maintaining its high fiber yield (Chee *et al* 2005a). The breeding value of an extra long staple (ELS) breeding line when crossed to a genotype with average fiber quality in F_2 population was determined by Hague *et al* 2011; they observed transgressive segregation and mid-parent heterosis; the ELS traits demonstrated a high degree of penetration in the F_2 populations. Capturing the ELS traits in high yielding germplasm will speed the development of cultivars with improved fiber quality.

Significant differences were recorded among some cotton varieties and their F_1 and F_2 hybrids for the mean performances and variances of some traits. F_2 hybrids had higher variances for lint yield and lint% whereas for fiber length, F_1s had more variance and in fiber uniformity, parental lines showed greater variance. Parents versus F_1 and F_2 hybrids expressed more variance than F_1 versus F_2 hybrids. There were great significant variations among F_2 progenies and their parents (Baloch, 2002 and Soomro *et al* 2008). Recently, Karademir *et al* (2011) and Kakar *et al* (2013) also indicated the presence of considerable genetic variability among the parents and their F_2 hybrids. More recently, Baloch *et al* (2016) recorded significant differences among F_2 hybrids and their parental lines. Most of the F_2 hybrids gave higher averages than their parents for all traits and displayed moderate to high heritability estimates for most traits and were generally associated with greater genetic advances which indicated the presence of appreciable genetic variability in F_2 populations attributable to additive genes.

Similar significant differences among cotton varieties and their F_1 and F_2 hybrids for mean performances and variances of yield and its components and fiber traits were observed in the Egyptian cotton (Mohamed *et al* 2001; Abd-El-Haleem *et al* 2010; Abou El-Yazied *et al* 2014 and Gibely, 2015). Gibely, (2015) recorded highly significant differences among four cotton varieties and their crosses in F_1 and F_2 generations for some characters, providing the presence of distinct genetic variability background of the parents. The variation due to parents vs. F_1 crosses was highly significant for all characters, confirming the presence of substantial amount of heterosis. Variance due to parents vs. F_2 was highly significant, confirming the presence of substantial amount of genetic variability. The average degree of dominance showed the presence of over-dominance for all characters in F_1 and partial dominance in F_2 generation.

Giza 86 and Suvin are long-staple varieties belong to *G. barbadense* and characterized by good fiber quality and high yield, while Giza 88 is an extra-long staple variety has superior fiber quality and lower yield. Because of their yield potential, Giza 86 and Suvin contain novel alleles for superior productivity; the introgression of their favorable alleles to Giza 88 would improve its productivity with maintaining its high fiber quality. The objective of this research was to measure yield and its components as well as fiber properties and to detect genetic variation and genetic effects associated with two Egyptian cotton varieties and Indian one as well as their respective F_2 populations to use in breeding programs to produce high yielding extra long staple cotton genotypes.

MATERIALS AND METHODS

The present study was carried out during 2014-2016 growing seasons at Sakha Agricultural Research Station, Agric. Res. Center, Kafr El-Sheikh governorate, Egypt. The main aim of this work was to study the variability in F_2 population in two hybrids resulted from crossing between an extra long x long staple varieties of cotton *Gossypium barbadense* L. namely Giza 88 as a female parent pollinated by Giza 86 and Suvin as male parents.

In 2014 growing season, selfed seeds of the three cotton varieties were planted and crossed to obtain F_1 seeds for the two crosses. In 2015 season, crossing was repeated to obtain more F_1 seeds, in addition, F_1 plants were self pollinated to obtain F_2 seeds. In 2016 season, seeds of parents and their derived F_1 and F_2 hybrids for each cross were planted in a randomized complete blocks design with three replications. Each replicate consisted of three rows for each of the parents and F_1's, and five rows for the F_2 populations, each row was 7.0 m long and 0.6 m in wide. Hills were 0.7 cm apart to insure 10 hills per row. Hills were thinned to one plant per hill at seedlings stage. All other normal cultural practices were applied as recommended for ordinary cotton cultivation. All individual plants were harvested and ginned in order to, estimate both agronomic and fiber quality characters as follows:

Yield and yield component traits

- Boll weight (B.W): Measured as the mean weight in grams of a random sample of 10 bolls from each plant.
- Seed index: The mean weight of 100 seeds in grams.
- Seed cotton yield / plant (S.C.Y): The weight of seed cotton yield for each plant in grams.
- Lint yield / plant (L.Y): The weight of lint yield for each plant in grams.
- Lint percentage (L %): Lint yield to seed cotton yield as Percentage.

Fiber properties

- Fiber length (F.L): Spans length in millimeter at 2.5% determined by the digital fibrograph.
- Fiber fineness (F.F): Expressed as Micronaire instrument reading.

- Fiber strength (F.S): Measured for flat-bundles of fiber using the Pressley tester at zero gauge length, and recorded as (Pressley index) values.
- Uniformity ratio (U.R): Staple uniformity is expressed as:

$$U.R\% = \frac{50\%\,\text{Spans length}}{2.5\%\,\text{Spans length}} \times 100$$

All fiber properties were measured in the laboratories of the Cotton Technology Research Division, Cotton Research Institute, ARC, Egypt.

Statistical and Genetic Analysis

The analysis of variance of the four basic populations (P_1, P_2, F_1 and F_2) was statistically analyzed using (RCBD) analysis of variance according to Steel and Torrie (1980). The significance of means was determined using the least significant difference (L.S.D). The variance of F_2 plants was calculated as the total phenotypic variance (V_p). The parental and F_1 variances were used to estimate the environmental variance (V_e). The genetic variance (V_g) was calculated as ($V_p - V_e$).

Broad-sense heritability (h^2_b %) = $\frac{Vg}{Vp} \times 100$

Mid-parent heterosis estimated as: (H.MP%) = $\frac{\overline{F_1} - \overline{MP}}{\overline{MP}} \times 100$

Better-parent heterosis estimated as: (H.BP%) = $\frac{\overline{F_1} - \overline{BP}}{\overline{BP}} \times 100$

Inbreeding depression (I.D %) = $\frac{\overline{F_1} - \overline{F_2}}{\overline{F_1}} \times 100$

Potence ratio: Degree of dominance (P) trait was calculated using potence ratio according to Smith (1952) as follows:

$$P = \frac{\overline{F_1} - \overline{MP}}{\frac{1}{2}(\overline{P_1} - \overline{P_2})} \times 100$$

Where: M.P =Mid parents value, $P_1$and P_2=higher and lower parent means.

RESULTS AND DISCUSSION

Mean squares obtained from the analysis of variance for the studied quantitative traits are presented in Table (1), which revealed that genotypic differences were highly significant among the parental cotton genotypes and their crosses in F_1 and F_2 generations for all the studied traits except for seed cotton yield that showed significant differences, providing the presence of distinct genetic variability background of the used parents that cleared in the partitioning of the genotypic variation where the parents showed highly

Table 1. Analysis of variance for genotypes (parents, F_1 and F_2) for the studied traits in the two crosses.

SOV	df	B.W (g)	S.I (g)	S.C.Y (g)	L.Y (g)	L%	F.L (mm)	Mic.	Pres.	U.R%
Replications	2	0.326	0.174	12037	1824.33	2.399	0.163	0.048	0.16	0.14
Genotypes	6	0.636 **	1.432 **	3338.79 *	1097.37 **	51.103 **	53.264 **	1.541 **	11.634 **	32.699 **
Parents (P)	2	0.675 **	0.942	7371.98 *	2696.24 **	134.07 **	130.44 **	4.489 **	32.081 **	43.251 **
F_1	1	1.276 **	0.051	1459.57	241.96	0.504	2.136 *	0.003	0.442 *	0.288 **
F_2	1	0.210	5.960 **	13.273	0.11	3.775	5.484 *	0.008	0.543	55.162 **
P *vs* F_1	1	0.901 **	0.553	4057.05 *	1435.97 **	72.079 **	75.103 **	2.294 **	17.050 **	35.227 **
P *vs* F_2	1	0.427 **	2.123 **	4542.77 *	1584.56 **	74.917 **	75.110 **	2.290 **	16.946 **	35.478 **
F_1 *vs* F_2	1	0.597 **	2.025 **	1283.90	195.06	1.619	2.561 **	0.003	0.334	36.457 **
Error	12	0.067	0.395	1346.02	192.16	1.428	0.471	0.038	0.160	0.589

*** and ** indicate significant at 0.05 and 0.01 probability levels, respectively.**

significant differences for most traits. Moreover, the variation due to parents vs. F_1 crosses was highly significant for most traits, confirming the presence of substantial amount of heterosis in these crosses while the variation due to parents vs. F_2 generation was also highly significant for most of the studied traits, confirming the presence of considerable genetic variability among the parents and their F_2 hybrids. These results are in agreement with those reported by Karademir *et al* (2011); Kakar *et al* (2013); Abou El-Yazied *et al* (2014); Gibely (2015) and Baloch *et al* (2016).

Mean performance:-

Mean performance of the studied traits for the parents and their F_1 and F_2 hybrids in both crosses in this study are presented in Table (2). F_1 hybrids showed the higher mean for boll weight and surpassed the parents and F_2 in both crosses indicating over-dominance for this trait whereas Giza 88 gave the lower boll weight in cross I and Suvin in cross II. The long staple variety in each cross (Giza 86 and Suvin) showed the higher values for both seed cotton and lint yields/plant in addition to lint% whereas the extra long staple variety (Giza 88) showed the lowest values in the two crosses while F_1 and F_2 showed intermediate values in this respect. Giza 88 gave the best values for fiber properties, i.e. length, fineness, strength and uniformity ratio in both crosses whereas Giza 86 and Suvin had the lowest

Table 2. Mean performance of the Parents, F_1 and F_2 for the studied traits in the two crosses.

Genotypes	B.W (g)	S.I (g)	S.C.Y (g)	L.Y (g)	L%	F.L (mm)	Mic.	Pres.	U.R%
	Cross I (Giza 88 x Giza 86)								
Giza 88	3.06	10.56	159.60	56.12	35.13	36.02	3.65	11.29	88.30
Giza 86	3.18	10.64	190.68	74.97	39.31	32.11	4.43	10.09	87.84
F_1	3.25	10.58	182.85	67.19	36.74	34.47	3.98	10.76	86.84
F_2	3.16	10.75	174.92	63.90	36.31	34.37	3.97	10.72	86.85
LSD 0.05	0.16	NS	13.86	8.05	0.66	0.45	0.13	0.25	0.36
0.01	0.22	NS	NS	10.90	0.98	0.56	0.16	0.33	NS
Cross II (Giza 88 x Suvin)									
Giza 88	3.06	10.56	159.60	56.12	35.13	36.02	3.65	11.29	88.30
Suvin	2.88	10.30	171.57	63.76	37.20	32.81	4.06	10.21	87.23
F_1	3.09	10.34	168.19	61.20	36.48	34.85	3.97	10.94	86.87
F_2	3.04	10.32	163.74	59.86	36.51	34.92	3.97	10.91	86.84
L.S.D 0.05	0.12	N.S	10.53	4.81	0.52	0.40	0.15	0.21	0.51
0.01	0.15	NS	13.02	6.40	0.70	0.52	0.19	0.29	0.63

Ns, * and ** indicate non significant, significant at 0.05 and 0.01 probability levels, respectively.

values for the first three traits while F_1 and F_2 had the lowest uniformity ratio in cross I and cross II, respectively. Similar significant genotypic effects among parents and their hybrids were observed by many authors (Mohamed *et al*., 2001; Cheatham *et al*., 2003; Jenkins *et al*., 2009; Abd El-Haleem *et al*., 2010; Hague *et al*., 2011; Kantartzi *et al*., 2011 and Gibely, 2015).

Means of F_1 generation were higher than either the highest parent (for boll weight) or mid-parent for most traits indicating over or partial dominance, respectively towards the respective parent. Meanwhile, F_1's was lower than the highest or mid-parent values for both seed index and uniformity ratio in both crosses in addition to lint % and micronaire reading in cross I, indicating that dominance was towards the lower parent. Same results outlined by Mohamed *et al*., (2001); Abd El-Haleem *et al*.,(2010); Hague *et al*., (2011); Nazmey,(2012); and Gibely, (2015).

Parents Vs F_2 population

1. Mean performance and range: Data concerning means and ranges of F_2 populations as compared to the parents for both crosses are presented in Table (3). F_2 population produced greater yields of seed cotton and lint cotton with heavier bolls and higher lint% as compared to the ELS parent

Table 3. Range and mean performance for parents and their F_2 generation for the studied traits in the two crosses.

Genotypes	Cross I (G.88 x G.86)							
	B.W		S.C.Y		L.Y		L%	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
P_1 (G.88)	2.70 – 3.91	3.06	94.20 – 238.30	159.60	33.30 – 90.10	56.12	33.68 – 38.11	35.13
P_2 (G.86)	2.68 – 3.64	3.18	127.20 – 322.50	190.68	53.29 – 124.30	74.97	36.28 – 41.89	39.36
F_2	2.61 – 4.22	3.16	58.30 – 288.10	174.92	19.41– 111.50	63.90	33.29 – 40.26	36.31
L.S.D 0.05		0.16		18.64		8.48		0.65
0.01		NS		NS		11.27		0.87
	F.L		Mic.		Press.		U.R	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
P_1 (G.88)	34.90– 37.00	36.02	3.30 – 4.00	3.65	10.50 – 12.30	11.69	83.90– 87.00	85.27
P_2 (G.86)	31.00– 33.20	32.11	3.90 – 4.80	4.43	9.00 – 10.40	9.69	83.90– 86.40	85.04
F_2	30.90– 37.00	34.37	3.40 – 4.80	3.97	8.80 – 12.10	10.72	82.50– 86.40	84.85
L.S.D 0.05		0.47		0.13		0.26		0.35
0.01		0.62		0.17		0.34		NS
Cross II (G.88 x Suvin)								
Genotypes	B.W		S.C.Y		L.Y		L%	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
P_1 (G.88)	2.85 – 3.28	3.06	130.87– 210.67	159.60	48.59– 78.98	56.12	33.68– 38.11	35.13
P_2 (Suvin)	2.60 – 3.20	2.88	125.66– 222.60	171.57	45.45– 83.46	63.76	35.05– 40.23	37.13
F_2	2.70 – 3.81	3.04	94.20– 238.30	163.74	33.30 – 90.10	59.86	32.02– 38.40	36.51
L.S.D 0.05		0.06		14.95		5.50		0.56
0.01		0.08		19.89		7.32		0.75
	F.L		Mic.		Press.		U.R	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean
P_1 (G.88)	34.90– 37.00	36.02	3.30 – 4.00	3.65	10.50– 12.30	11.69	83.90– 87.00	85.27
P_2 (Suvin)	32.00 – 33.43	32.81	3.79 – 4.40	4.06	9.41 – 11.03	10.21	83.21– 89.10	87.23
F_2	34.00 – 36.56	34.92	3.40 – 4.80	3.97	9.22 – 11.45	10.91	84.40– 89.21	86.84
LSD 0.05		0.20		0.07		0.15		0.41
0.01		0.26		0.10		0.20		0.55

(Giza 88) but the increments were not significant for the aforementioned traits. Contrarily, fiber length, fineness, strength and uniformity for F_2 were not improved over Giza 88 that had significant better fiber properties than F_2 population.

On the other hand, the long staple variety (Giza 86) showed greater yields of seed cotton and lint with heavier bolls, higher lint% and fiber uniformity ratio as compared to F_2 population; whereas fiber length, fineness and strength were significantly improved in F_2 as compared to Giza 86 parent. Our results were in harmony with those of Jenkins *et al* (2009) and Hague *et al* (2011). Kantartzi *et al* (2011) in a cross between *G.barbadense* and *G. hirsutum*, found that the traits lint yield and lint % were closer to the values of *G. hirsutum* than of *G. barbadense* suggesting partial dominance of the first parent for these traits. Whereas fiber properties showed to be either the same or significantly improved than *G.hirsutum* but not as those of *G.barbadense*. Some generations of back crossing to the desired parent are required to catch the desired improvements. The same interpretation could be introduced in our study as the majority of productivity traits were closer to the long-staple variety (Giza 86) than the extra-long staple variety (Giza 88) suggesting partial dominance of the long staple variety. On the contrary, fiber quality traits were closer to the extra-long staple variety.

With regard to the extent of variability, F_2 population showed the wider ranges of as compared with the parents in both crosses. Meanwhile, the wider ranges were extended towards both negative and positive directions and showed appreciable amounts of segregants which biased the maximum and minimum limits of their parents. This could be emphasized by the recorded values of the phenotypic variability.

2. Phenotypic variance and coefficient of variability: Total phenotypic variance (V_p) and coefficient of variability (C.V%) for the parents and their F_2 generation were presented in Table (4). The data showed that the segregating population (F_2) had the higher variance for all traits in the two crosses as compared to the parents. Theoretically, F_2 hybrids are expected to show more variance than the parents and F_1 hybrids due to the high frequency of gene recombination. Similar results were observed by Mohamed *et al* (2ool); Baloch *et al* (2002); Kantartzi *et al* (2011) and Baloch *et al* (2016). The higher variance in F_2 populations as compared to the parents in both crosses reflecting the efficiency of artificial hybridization in inducing variability in the studied genotypes. Yield and its components traits had higher variation than fiber quality traits for all genotypes in both crosses.

Since the variation depends upon the magnitude of the measuring units of the trait, coefficient of variation (C.V%) is independent on the measuring units so it is more useful in comparing the populations. Data presented in Table (4) indicated that F_2 population also showed the higher C.Vs than the parents in both crosses for all the studied traits (except for boll weight in cross I) which emphasize the induced variability by hybridization in the used genotypes.

Table 4. Phenotypic variance (Vp) and coefficient of variability (C.V%) of Parents and their F_2 for the studied traits in the two crosses.

Genotype	Cross I (G.88 x G.86)							
	B.W		S.C.Y		L.Y		L%	
	Vp	C.V%	Vp	C.V%	Vp	C.V%	Vp	C.V%
P_1 (G.88)	0.098	10.212	2085.515	28.614	268.143	29.180	0.720	2.415
P_2 (G.86)	0.086	9.225	2144.546	24.286	304.188	23.265	1.561	3.174
F_2	0.130	11.412	2366.853	27.812	372.540	30.205	2.125	4.014
Genotype	F.L		Mic.		Press.		U.R	
	Vp	C.V%	Vp	C.V%	Vp	C.V%	Vp	C.V%
P_1 (G.88)	0.212	1.278	0.052	6.214	0.150	3.316	0.396	0.738
P_2 (G.86)	0.565	2.342	0.057	5.403	0.190	4.492	0.412	0.754
F_2	1.083	3.027	0.090	7.558	0.334	5.391	0.640	0.942
Cross II (G.88 x Suvin)								
Genotype	B.W		S.C.Y		L.Y		L%	
	Vp	C.V%	Vp	C.V%	Vp	C.V%	Vp	C.V%
P_1 (G.88)	0.098	10.212	2085.515	28.614	268.143	29.180	0.720	2.415
P_2 (Suvin)	0.091	10.480	2080.029	26.582	284.468	26.451	2.939	4.617
F_2	0.118	11.289	2315.869	29.390	327.446	30.226	3.839	5.356
Genotype	F.L		Mic.		Press.		U.R	
	Vp	C.V%	Vp	C.V%	Vp	C.V%	Vp	C.V%
P_1 (G.88)	0.212	1.278	0.052	6.214	0.150	3.316	0.396	0.738
P_2 (Suvin)	0.290	1.642	0.074	6.701	0.125	3.463	0.543	0.845
F_2	1.676	3.708	0.110	8.353	0.263	4.699	1.462	1.394

The highest C.V% observed for the traits seed cotton and lint yields in both crosses (27.812 and 30.205, respectively in cross I as well as 29.390 and 30.226 in cross II) indicating that selection can be applied on the two traits to isolate more productive promising lines. These results were similar to those recorded by Kantartzi *et al* (2011) and Ahsan *et al* (2015).

Baloch *et al* (2002) reported that cotton germplasm generally developed through a pedigreed breeding program in which individual plants are selected from a segregating population. A higher coefficient of variation would imply a greater likelihood of finding transgressive segregants.

Moderate C.Vs were observed in this study for boll weight and micronaire value, similarly, Harshal (2010) and Ahsan *et al* (2015) also recorded moderate C.V% for some cotton traits and suggested that these traits can be improved by the vigorous selection. On the other hand, lint%, fiber length, pressely index and uniformity exhibited low C.Vs indicating that the breeders need source of high variability for these traits to make improvement. Same results were recorded by Kantartzi *et al* (2011) and Ahsan *et al* (2015).

Cross II gave higher C.Vs than cross I for most of the studied traits which indicated that the introgressed variety Suvin induce more variability when it crossed with the Egyptian variety than the induced variation in the cross between the Egyptian varieties.

Genetic parameters in F_2 generation

1. Variability: Genetic parameters measured in F_2 are presented in Table (5). Phenotypic, genotypic and environmental variances for the two crosses in this study revealed that the trait seed cotton yield/plant exhibited the highest phenotypic and genotypic variances i.e. (2366.85 and 226.49, respectively in cross I and 2315.87 and 199.44 in cross II), followed by lint yield/plant that gave 372.54 and 81.19 in cross I as well as 327.44 and 47.39 in cross II.

2011).

Table 5. The genetic parameters in F_2 generation for all studied traits in the two crosses.

Traits	B.W (g)	S.I (g)	S.C.Y (g)	L.Y (g)	L%	F.L (mm)	Mic.	Pres.	U.R%
	Cross I (Giza 88 x Giza 86)								
V_p	0.130	0.663	2366.853	372.540	2.125	1.083	0.090	0.334	0.640
V_g	0.035	0.189	226.496	81.192	0.837	0.598	0.033	0.152	0.210
V_e	0.095	0.474	2140.357	291.348	1.288	0.485	0.056	0.182	0.430
h^2_b	27.12	28.51	9.57	21.79	39.39	55.24	37.20	45.44	32.78
H.MP%	7.329	0.164	4.402	2.505	-1.291	1.204	-1.526	0.639	-0.387*
H.BP%	5.304	-0.222	-4.106	-10.384	-6.534*	-4.285*	10.158	-7.958*	-0.539*
I.D%	5.594	-3.130	4.334	4.888	1.176*	0.297	0.335	0.310	-0.017*
P	0.147	0.003	0.088	0.050	-0.026	0.024	-0.031	0.013	-0.008
	Cross II (Giza 88 x Suvin)								
V_p	0.118	0.437	2315.869	327.446	3.839	1.676	0.110	0.263	1.462
V_g	0.029	0.075	199.442	62.394	1.547	1.004	0.040	0.110	0.571
V_e	0.089	0.362	2116.427	265.052	2.292	0.672	0.070	0.153	0.891
h^2_b	24.58	17.16	8.61	19.05	40.30	59.90	36.50	41.80	39.06
H.MP%	2.020*	-0.863	1.573	2.105	0.865	1.269*	2.939	-4.519	1.965*
H.BP%	0.980	-2.083	-1.970	-4.015	-1.935*	-3.239*	-2.217*	-8.100*	-0.272*
I.D%	-0.330	0.193	2.646	2.190	-0.082	-0.201*	0.084	-1.583	-0.418*
P	0.040	-0.017	0.031	0.042	0.017	0.025	0.059	-0.090	0.039

*** indicates significant at 0.05 probability level; H^2_b: Broad sense heritability; H.MP: Mid-parents heterosis; H.BP: Better parent heterosis; I.D: Inbreeding depression and P: Potance ratio**

Micronaire value had the lowest phenotypic and genotypic variances as it had 0.090 and 0.033, respectively in cross I as well as 0.110 and 0.040 in cross II followed by boll weight that gave 0.130 and 0.035 in cross I while cross II gave 0.118 and 0.021, respectively. In general, the productivity traits showed larger variances as compared to fiber quality traits.

There were great differences between phenotypic and genotypic variations that representing the environmental variation for all traits in this study (except for fiber length) which indicating the great effect of environment on these traits and environmental fluctuations had a share in the expression of the studied traits. Our results agreed with those of Mohamed *et al* (2ool); Kantartzi *et al* (2011); Kakar *et al* (2013) and Baloch *et al* (2016).

2. Heritability: Broad-sense heritability (h^2_b) values were generally higher for fiber traits than productivity traits. High h^2_b values (exceeded 50%) were recorded for fiber length in both crosses i.e., 55.24% in cross I and 59.9% in cross II, indicating that effective selection could be practiced on individual plant basis during early segregating generations. Similar trend for fiber length was recorded by Weaver and Badger (2006) and Hague *et al* (On the other hand, moderate h^2_b values (30–50%) were recorded for the traits lint%; fiber fineness; fiber strength and uniformity. On the contrary, low h^2_b values (less than 30%) were observed for boll weight, seed index seed cotton and lint yields reflecting the great effects of environment on these traits and environmental fluctuations had a share in the expression of such traits, therefore, improving these traits needs intensive selection during later generations. Our findings were in agreement with Mohamed *et al* (2001); Weaver and Badger (2006) Hague *et al* (2011) and Baloch *et al* (2016).

3. Heterosis: Mid-parent heterosis in F_1 populations was low for most agronomic and fiber-related traits (Table 5). Data revealed negative significant heterosis relative to mid-parents for uniformity ratio(- 0.387) in cross I, whereas the rest of traits showed insignificant heterotic effects that ranged from -1.526 for micronaire reading up to 7.329 for boll weight. In cross II the mean of F_1 hybrids were greater than the mean of parents reflecting positive significant heterotic effects for the traits boll weight (2.020), fiber length (1.269) and uniformity ratio (1.965), while the rest of traits showed insignificant heterotic effects. Moreover, insignificant positive heterotic effect relative to the better parent was detected only for boll weight in both crosses. Whereas, the traits lint%, fiber length, micronaire reading, pressely index and uniformity ratio showed negative significant values in the two crosses of this study. The rest of traits showed negative insignificant heterotic effects. Similar positive or negative heterotic effects were recorded for cotton traits **(**Baloch *et al* 2002**;** Abd-El-Haleem *et al* 2010; Hague *et al* 2011 and Yehia, 2016).

4. Inbreeding depression (I.D%): Theoretically, F_2 hybrids are expected to show inbreeding depression as the expression of heterosis in F_1 will be followed by a respective reduction in F_2 due to the direct effect of homozygosity. I.D% showed positive values for most of the studied traits in cross I, out of these traits only lint% gave significant positive value, whereas two traits viz: seed index and uniformity ratio gave negative values. In cross II, most of the studied traits (seed index, seed and lint cotton yields and micronaire reading) showed insignificant positive values of I.D%; whereas the rest of traits showed insignificant negative values except for fiber length and uniformity that reached the significant level. Our results were in harmony with other investigators who found positive or negative values of inbreeding depression in cotton traits (Mohamed *et al*., 2001; Baloch *et al* 2002; Abd-El-Haleem *et al* 2010; Nazmey, 2012 and Yehia, 2016).

5. Potance ratio (P): It was used to determine the degree of dominance as follows: Complete dominance is indicated when P= ±1.0, while partial dominance is considered when P is between ± 1.0, except the value zero which indicates absence of dominance. When P value exceeds +1.0 it indicates over dominance. The positive and negative signs indicate the direction of dominance to either higher parent or lower parent, respectively (**Smith, 1952)**. Data concerning potence ratio (P) for the two crosses in this study are presented in Table (5). All traits in both crosses showed partial dominance, the direction was toward the higher parent for most traits whereas it was to the lower parent for, lint%, micronaire reading and uniformity in cross I as well as seed index and pressely index in cross II. Our findings were in agreement with those reported by Mohamed *et al*., (2001) and Nazmey (2012) who found partial dominance for some traits in Egyptian cotton.

Some of F_2 individual plants gave higher yield and/or fiber quality as compared to their parents; these results suggest that there is a strong potential of F_2 hybrids for such traits, which may possibly due to unidentified transgressive segregation which may still give more yield and fiber quality than parents and F_1 hybrids. Some of F_2s showed better performance than parents and F_1 hybrids were also reported by several researchers (Baloch *et al* 2002; Jenkins *et al* 2009; Hague *et al* 2011 and Baloch *et al* 2016). Hence, identification and selection of such higher-performing individuals provides dependable tools to the cotton breeder for crop improvement through using selected individual plants in a pedigreed breeding program.

CONCLUSIONS

Out of this study, it could be concluded that crossing between extra-long and long staple cotton varieties failed to produce high yielding extra-long staple population in F_2, where neither of the F_2 populations in both crosses exceeded the high parental mean for any economical trait (yield and fiber quality) although some of F_2 individual plants gave higher yield and/or fiber quality than their parents. The value of these populations likely will be derived from the selected individual plants to be used in a pedigreed breeding program for increasing yield potential in the extra long staple variety Giza 88.

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تـايـ الـ الـانى لهـ بـ صـ فائـ الـ ل

وصـ الـ لة فى القـ الـ

عـادعـ العـ عامـ ، حـ أمـ الـ ى و ة حـ الـ حامـ

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تهـف هـ ه الـ راسة الى تقـ يـ الـ ايـ فى عـ ائـ الـ الـ انى الـ اتـ ة مـ تهـ صـ قـ مـ فائـ الـ ل مع صـ فـ مـ القـ الـ لة للإسـ فاده مـ ها لـ ادة انـ اجـ ة الـ فائـ الـ ل. تـ الـ هـ بـ الـ جـ ة ٨٨ فائـ الـ ل أم والـ الـ لة جـ ة ٨٦ لإنـ اج الـهـ الأول والـ سـ فـ لإنـ اج الـهـ الـ انى. تـ زراعة الآ اء والـ هـ بـ ها لإنـ اج بـ رة الـ الأول مـ سـ ٢٠١٤م وفى الـ سـ الـ انى تـ إعادة الـ هـ لإنـ اج مـ مـ بـ رة الـ الأول ا تـ زراعة بـ رة الـ الأول لإنـ اج بـ رة الـ الـ انى لـ لا الـهـ . تـ زراعة الآ اء والـ لـ الأول والـ انى فى تـ قـ اعات املة العـ ائـ ة مـ ٣ مـ رات خلال الـ سـ الـ الـ (٢٠١٦م) وتـ تـ الـ فات الـ روسة على الـ اتات الفـ دـ ة لـ العـ ائـ الـ روعه. و انـ اهـ الـ ائج الـ علـ ها ا يلى: ١- أ هـ ت الـ اكـ الـ راثـ ة (الآ اء وهـ الـ لـ الأول والـ انى) فى لا الـهـ اخـ لافات معـ ة لـ الـ فات الـ روسة مـ ا عـ الـ ع الـ راثى للآ اء الـ مة. ا أن الـ ايـ بـ الآ اء وهـ الـ الـ انى ان معـ ا لـ عـ الـ فات. ٢- أعـ ى الـ فان لا الـ لة (جـ ة ٨٦ وسـ فـ) أعلى الـ سـ ات لـ فات الإنـ اجـ ة بـ ا أعـ ى الـ فائـ الـ ل (جـ ة ٨٨) أعلى الـ سـ ات لـ فات جـ دة الـ لة فى حـ اعـ هـ الـ لـ الأول والـ انى ا مـ سـ ة . أعـ هـ الـ الـ انى مـ سـ ات أعلى لـ ل الـ ات مـ القـ الـ هـ والـ عـ والـ افى ومـ سـ وزن اللـ زة مقارنة الـ جـ ة ٨٨ بـ ا صفات جـ دة الـ لة انـ أفـ فى الـ جـ ة ٨٨ والعـ الـ ة للـ الـ لة فى هـ . ٣- الـ ة للـ ايـ الـ ث فقـ أ هـ ت هـ الـ الـ انى مـ أوسع و أعلى للـ ايـ الـ لى ومعامـ الإخـ لاف مقارنة الآ اء لـ الـ فات الـ روسة فى لا الـهـ مـ ا عـ فعالـ ة الـهـ الـ اعى فى اسـ اث الـ ايـ فى الأصـ اف الـ مة فى هـ ه الـ راسة. وقـ أ هـ الـهـ

الـ انـى (جـ ة ٨٨ × سـ فـ) أعلى للـ ايـ مقارنة الهـ الأول (جـ ة ٨٦ × جـ ة ٨٨) لـ عـ الـ فات الـ روسة مـ ا يـل على أن الـ الـ لـ (سـ فـ) أعـ ى تـ ايـ أعلى عـ تهـ ه الأصـ اف الـ ة مقارنة الـ ايـ الـ اتـج عـ الـ هـ بـ الأصـ اف الـ ة فقـ . ٤- أ هـ ت صفات جـ دة الـ لة فاءة تـ ر عالـ ة مقارنةً فات الـ ل ومـ ناته وقـ أعـ صفة ل الـ لة عالـ ة لـ فاءة الـ ر فى لا الهـ ، بـ ا أ هـ ت الـ فات الـ افى، الـ عـ مة، الـ انة والإنـ ام مـ سـ ة لـ فاءة الـ ر ؛ فى حـ أعـ الـ فات وزن اللـ زة، معـ ل الـ رة ومـ ل الـ ات مـ القـ الـ هـ والـ عـ ا مـ فـ ة لـ فاءة الـ ر . ٥- سـ لـ معـ الـ فات الـ روسة قـ ة هـ مـ فـ ة فى الـ الأول بـ ا أعـ ى الـ هـ ر الـ اتـج عـ الـ ة الـ اخلـ ة أ مـ جـ ة لـ عـ الـ فات الـ روسة. ٦- أ هـ ت الـ فات الـ روسة سـ ادة جـ ئـ ة و ان إتـ اه الـ ادة نـ الأب الأعلى لـ عـ الـ فات. ٧- لـ تـ فـ ق عـ ائ الـ الـ انـى فى لا الهـ على الأب الأعلى لأ مـ الـ فات الإقـ ادـ ة (صفات الـ ل وجـ دة الـ لة) على الـ غـ مـ أن عـ الـ اتات الفـ دـ ة للـ الـ انـى أ هـ ت مـ سـ ات أعلى لـ فات الـ ل أو جـ دة الـ لة أو لاهـ ا معا مقارنةً الآ اء و ة هـ ه العـ ائ تـ فى انـ اب الـ اتات الفـ دـ ة الـ فـ قة وسـ امها فى بـ نامج الـ ة الـ . ٨- مـ هـ ه الـ راسة هـ أن الـ هـ بـ صـ قـ فائ الـ ل وصـ الـ لة لـ يـ دـ إلى تـ انـ اجـ ة الـ فائ الـ ل أو تـ خـ اص الـ لة للـ الـ بـ رجة معـ ة فى عـ ائ الـ الـ انـى. لـ أ هـ ت عـ الـ اتات الفـ دـ ة للـ الـ انـى مـ سـ ات أعلى لـ فات الـ ل أو جـ دة الـ لة أو لاهـ ا معا مقارنةً الآ اء و الـ الـى انـ اب هـ ه الـ اتات الفـ دـ ة الـ فـ قة وسـ امها فى بـ نامج الـ ة الـ لإنـ اج سلالة تـ الإنـ اجـ ة العالـ ة الـى جانـ صفات الـ لة الـ ازة.