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Seed Oil Content, Yield and Fiber Quality Traits in Some Egyptian Cotton Genotypes

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ABSTRACT

This work was done at Sakha Agricultural Research Station,during 2018 and 2019 seasons.The aim was evaluating cottonseed oil content,yield and its components and fiber traits of some Egyptian genotypes to improve seed oil content with the other economic traits during selection of new promising crosses.Eighteen extra-long staple genotypes were planted in a randomized complete block design with four replications.Traits studied were:Boll weight,seed cotton,lint and seed yields,lint%,seed index,fiber fineness,strength,length,length uniformity index,seed oil content and seed oil index. Results indicated high level of variability among genotypes in all traits.Most of traits differed significantly from one year to another;genotypes x years interactions were significant for some traits.Genotypes were divided into four groups according to their oil content:high,moderately high, moderately low and low oil content.Phenotypic and genotypic variances showed wide variability in the studied traits, moderate PCV values were recorded for seed cotton, lint and seed yields, GCV showed low values in all traits, suggesting the difficulty of manipulating these traits through plant breeding. Heritability recorded high values for: lint%, fiber fineness and seed index. None of the studied traits showed high expected genetic advance under selection. Seed oil content and seed oil index showed positive significant correlation with seed index, fiber strength and length uniformity index, whereas correlation was significant negative with lint yield and lint%. The highest oil content was achieved by three genotypes "G.93 x [G.76 x (G.45 × sea Island)]", (G.93 x G.87) and Giza 92, the three genotypes might be used to improve oil content in Egyptian cottonseed.

Keywords: Egyptian cotton, oil content, variance, heritability, genetic advance.

INTRODUCTION

Cotton (*Gossypium Spp.* L.) is the most important fiber crop worldwide and its production has been restricted by lint yield and fiber properties, moreover, cottonseeds are considered as an oilseed crop because of their distinctive uses and economic importance.

Cottonseed oil that makes up around 16% of the seed weight is the most valuable product derived from cottonseed (Liu *et al*., 2009). Moreover, Dinesh *et al*., (2003) reported that cottonseed oil is considered as a healthy vegetable oil and is one of the few oils advised for reducing saturated fat intake and can be used as vegetable oil, in addition, cottonseed contain 20-25% protein so its cake is very rich with protein and can be used as feed of cattle.

Realization of the nature and extent of genotypic and phenotypic variation present in cotton crop has an important role in establishing successful breeding program for produce superior varieties in yielding ability and fiber properties. Moreover, Vekariya *et al*., (2016) added that a high yielding genotype must be rich in seed oil and protein contents as well as containing low gossypol to relieve the present need of oil and protein as feed.

Fiber yielding ability in cotton varieties has improved successfully over the last few decades through breeding and management techniques. Contrary, cotton breeders did not pay much attention to improving quality and quantity of oil and protein contents even though there is enormous potential for the improvement of such traits, many cotton breeders have emphasized the importance of developing new varieties with higher oil and protein content to face up the needs of food supply and nutrition (Hinze and Kohel, 2012).

Availability of appropriate genetic variability is essential requirement to screen the available genetic material and selection of economically important traits. Quantitative assessment of the patterns of genotypic variation and the nature of associations between main traits of yield, fiber quality and sees oil content in cotton provide useful information required for selection for high oil content. It is fortunate that the modern cotton genotypes in Egypt possess substantial levels of seed oil without any conscious selection for this trait in the past (Mohamed-Amal *et al*., 2010, Shakr *et al*., 2017, and Lamlom *et al*., 2020). Evaluating genotypes of the gene pool would provide base information on the role of different traits important in improving seed oil content.

A large range of genetic variability existed among cotton varieties in seed oil content were recorded by several researchers in *G. hirsutum* (Hinze *et al*. 2015, Campbell *et al*., 2016, Vekariya *et al*., 2016, Shakeel *et al*., 2018 and Iqbal *et al*., 2020), as well as in *G. barbadense* (Ahmad and Hassan, 2014, Abd El-Aty *et al*., 2015, Abd El-Moghny *et al*., 2015, Shakr *et al*., 2017 and Lamlom *et al*., 2020), which suggested the possibility of selection of genotypes on the basis of seed traits.

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Kothari *et al*., (2016) reported that seed oil content was found to be a heritable trait (H^2 = 0.52), and there was sufficient additive variance available for plant breeders to improve seed oil content. Moreover, Mert *et al*., (2004) found that dominance (h), additive x additive (i) and dominance x dominance (l) gene actions play a role in the inheritance of cotton seed oil content.

In the same connection, the environment sum of square was found to be accounted for the largest amount of total variation for seed oil (55%). Genotype x environment interaction was significant and accounted for 24% of the total variation for seed oil (Campbell *et al*., 2016). Wu *et al*., (2009) found that genotypic effect was more important than genotype by environment interaction effect for seed oil %, and oil index. They concluded that agronomic traits and seed nutrition contents can be improved simultaneously while improving seed traits and will also result in the improvement of fiber quality.

This work was achieved to evaluate cottonseed oil content as an economic trait in addition to yield and its components as well as fiber quality traits of some Egyptian extra-long staple genotypes as an attempt to improve seed oil content with the other economic traits during the selection of new promising crosses.

MATERIALS AND METHODS

This study was accomplished during 2018-2019 seasons at Sakha Agric. Res. Station, Agric. Res. Center, Kafr El-Sheikh governorate, Egypt.

Plant materials in this study contained eighteen extra-long staple cotton genotypes belong to *Gossypium barbadense* L. These genotypes are:

1- Giza 87 x C.B 58	10-Giza 93 x Giza 87
2- Giza 93 x Giza 71	11-Giza 93 x Giza 88
3- Giza 92 x Pima H.G.O	12-Giza 92 x Pima S_1
4- Giza 96 x Giza 45	13-G.93 x [G.76 x (G.45 x S.I.)]
5- Giza 96 x Giza 93	14-Giza 87
6- Giza 88 x Pima H.G.O	15-Giza 88
7- G.93 x{G.87 x [G.84 x (G.70x G.51B)]}	16-Giza 92
8- G.93 x{(G.84 x F.108) x [(G.84 x G.45) xG.45]}	17-Giza 93
9- G.96 x{(G.84 x F.108) x [(G.84 x G.45) xG.45]}	18-Giza 96

In both seasons, seeds of the eighteen cotton genotypes were planted in a randomized complete block design with four replications. Each plot consisted of five rows 4.0 m long and 0.65 m in wide. Hills were 0.25 m apart as recommended in the normal cultivation. Hills were thinned to two plants per hill. All other cultural practices were accomplished as recommended package for ordinary cotton cultivation.

The Following traits were estimated:

Boll weight (BW) in grams, seed index (SI) the weight of 100 seeds in grams, the three guarded rows of each plot were hand-picked to determine seed cotton yield (SCY), lint yield (LY) and seed yield (SY)/ plot in kilograms and lint percentage was calculated as follows:(L%= lint yield x 100/ seed cotton yield). In addition to fiber quality traits: fiber fineness (FF) as micronaire instrument reading, fiber strength (FS, g/tex) and fiber length (FL) as the upper half mean length (mm), measured by the digital fibrograph, length uniformity index (LU%) which is the ratio between the mean length and the upper half mean length of the fibers as a percentage.

Fiber traits were measured using High Volume Instrument (HVI) technology according to (A.S.T.M., D-1776-1998). Oil content as percentage of cotton seed was determined based on the methods described by the Association of Official Analytical Chemists (AOAC, 2004). In addition, seed index trait for oil, (OI) which is the weight of oil in 100 seed, was determined as described by Wu *et al*., (2009) as follows: (OI = seed oil% x seed index). All fiber properties and seed oil content were measured in the laboratories of Cotton Technology Research Division, Cotton Research Institute, Agricultural Research Center, Giza, Egypt.

Statistical and Genetic Analysis

Initially, individual year data were analyzed and homogeneity of variance tests were conducted to determine if a combined analysis of variance could be conducted. After confirming homogenous error variance, a combined analysis of variance was employed. The obtained data was subjected to standard analysis of variance as single year and as a combined analysis for the two growing seasons according to Steel *et al*., (1997). Differences among means were compared using the least significant difference (L.S.D) test as follows:

$$\mathbf{L.S.D_{\alpha} = t_{\alpha} \; x \; \sqrt{(2MS\acute{e}/r)}}$$

Data on all indices were subjected to estimation of genetic parameters like genotypic and phenotypic variances, coefficients of genotypic and phenotypic variability and heritability according to Burton and Devane (1953). Correlation coefficients were conducted following the procedure developed by Wright (1921).

In addition, the following genetic parameters were estimated for each trait from the ANOVA mean squares in the combined data: genotypic and phenotypic variances as outlined by Miller *et al*., (1958).

Heritability in broad sense as well as coefficients of genotypic and phenotypic variability were estimated according to Burton and Devane (1953).

The expected genetic advance under selection as percentage of the mean (GS) was estimated as outlined by Johanson *et al*., (1955).

The simple correlation coefficients (r) were calculated using the formula suggested by Falconer and Mackay (1996) to determine the degree of association of different traits, and significance of correlations was tested by comparing the computed values against tabulated values at d.f = n-2.

RESULTS AND DISCUSSION

Analysis of variance

The analyses of variance (ANOVA) for 18 cotton genotypes for the studied traits are presented in Table (1). Genotypes mean squares were highly significant ($p \leq 0.01$) for all the studied traits (except for uniformity ratio in year 2 and the combined data), which indicated that genotypes differ in their genetic potential and there is considerable genetic variability among these genotypes for the studied traits, which suggested abundant extent for genetic improvement of such traits through hybridization followed by directional selection.

These results are in line with those of previous works that recorded significant variability among cotton germplasm in yield and its component, fiber quality traits as well as seed oil content in *G. hirsutum* (Hinze *et al*. 2015, Vekariya *et al*. 2016, Shakeel *et al*. 2018, Hampannavar *et al*. 2020 and Iqbal *et al*. 2020), as well as in *G. barbadense* (Mohamed-Amal *et al*. 2010, Ahmad and Hassan, 2014, Abd El-Moghny *et al*. 2015, Shakr *et al*. 2017 and Lamlom *et al*. 2020).

Concerning the effect of different growing years, data denoted that most of the studied traits differ significantly from one year to another over the tested genotypes except for boll weight, lint%, fiber fineness and seed index, indicating the different effect of the climatic factors prevailing during the growing season on the mean values of the studied traits. Our results were in harmony with those obtained by Mohamed-Amal *et al*., 2010, Ahmad and Hassan, 2014, Abd El-Aty *et al*., 2015 and Shakr *et al*., 2017 who found significant effect of growing season on cotton yield and some yield component, some fiber quality and cottonseed traits.

Regarding the genotypes in years (G x Y) interaction, combined data over the two years presented in Table (1) revealed significant interactions for the traits: boll weight, lint%, fiber strength, length uniformity index, seed oil% and seed oil index indicating that the relative performance of the genotypes tended to rank consistently different in different seasons, hence, it would certainly be necessary to test genotypes in more than one year for effective selection for improving these traits, these results may be attributed to the fact that each variety needs proper climatic condition to express its different potentialities. On the contrary, the traits, seed cotton yield, lint yield, fiber fineness, fiber length, seed index and seed yield showed insignificant (G x Y) interaction, indicating that the relative performance of genotypes was essentially the same in each of the two years of study. However, this means that selection for improving such traits at one season might be effective for broad range of growing seasons which is encouraging from the breeder's view point. Our results were in agreement with those obtained by: Mohamed-Amal *et al*., 2010, Ahmad and Hassan, 2014, Abd El-Aty *et al*., 2015, Abd El-Moghny *et al*., 2015, Shakr *et al*., 2017 and Iqbal *et al*., 2020.

Genotypes mean performance:

Mean performance of the studied traits for the 18 extra-long staple cotton genotypes as combined data over years are presented in Table (2).

Yield and yield component traits

Boll weight (g): (BW), overall BW managed by 18 different cotton genotypes ranged from 2.97 g for genotype 10 (Giza 93 x Giza 87) to 3.09 g for the genotype 1 (Giza 87 x C.B 58). However, the studied genotypes were divided to two groups concerning BW with significant differences between the two groups and insignificant differences within each group. The first group had the highest values and comprised 9 genotypes (1,2,3,4,5,6,16,17 and 18) whereas the second group had the lowest values and contained the other 9 genotypes (7,8,9,10,11,12,13,14 and 15).

Seed cotton yield/ Plot (Kg): (SCY/P.) ranged from 3.382 Kg obtained by Giza 87variety (genotype 14) to 4.658 Kg obtained by genotype 2 (Giza 93 x Giza 71). Generally, the tested genotypes could be divided into three groups according to their yielding potentiality with significant differences among them, the first group contained 4 genotypes (1, 2, 5 and 11) that yielded the highest SCY and significantly surpassed the other genotypes. On the contrary, 4 genotypes (4, 14, 15 and 18) yielded the lowest SCY with significant differences between them and the rest of genotypes. The rest of genotypes were intermediate in this respect.

Table 1. Mean squares obtained from analysis of variance for 18 cotton genotypes in both years and their combined data for the studied traits.

S.O.V.	d.f	Yield and yield component traits				Fiber traits				Seed Traits			
		BW (g)	SCY (kg/plot)	LY (kg/plot)	L %	FF Mic.	FS (g/tex)	FL (mm)	LU %	SI (g)	SY (kg/plot)	Oil %	OI (g)
						2018							
Reps	3	0.008	0.179	0.024	0.642	0.045	0.518	0.439	0.211	0.586	0.074	0.590	0.012
Genotypes	17	0.013 **	0.486 **	0.066 **	4.388 **	0.081 **	23.524 **	2.221 **	5.183 **	0.686 **	0.212 **	5.977 **	0.057 **
Error	51	0.005	0.100	0.157	0.028	0.012	1.530	0.228	0.598	0.136	0.042	0.704	0.018
						2019							
Reps	3	0.011	0.315	0.039	0.441	0.038	0.577	0.772	1.229	0.423	0.135	0.173	0.018
Genotypes	17	0.004 **	0.763 **	0.122 **	8.612 **	0.071 **	1.503 **	1.867 **	2.659 _	0.544 **	0.256 **	7.430 **	0.072 **
Error	51	0.002	0.229	0.032	0.274	0.015	0.313	0.674	1.716	0.064	0.092	0.226	0.006
						Combined							
Year	1	0.0001 _	14.260 **	1.716 **	1.619 _	0.012 _	218.301 **	7.701 *	4.988 *	0.003 _	6.082 **	170.956 **	1.707 **
Reps x Y	6	0.009	0.247	0.032	0.470	0.041	0.547	0.605	0.720	0.505	0.105	0.382	0.015
Genotypes	17	0.010 **	1.014 **	0.158 **	10.741 **	0.145 **	13.838 **	3.498 **	1.287 _	1.165 **	0.417 **	9.502 **	0.093 **
Y x G	17	0.007 *	0.145 _	0.030 _	2.244 **	0.007 _	11.189 **	0.590 _	6.555 **	0.064 _	0.050 _	3.906 **	0.035 **
Error	102	0.003	0.164	0.023	0.373	0.013	0.922	0.451	1.157	0.100	0.067	0.465	0.012

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

Table 2. Mean performance of 18 cotton genotypes for the studied traits combined over two years

Genotypes		Yield and yield component traits				Fiber traits				Seed Traits			
		BW	SCY	LY	L	FF	FS	FL	LU	SI	SY	Oil	OI
		(g)	kg/plot	kg/plot	%	Mic.	g/tex	mm	%	(g)	kg/plot	%	(g)
1	Giza 87 x C.B 58	3.09	4.467	1.538	34.42	3.34	46.23	36.55	86.53	10.23	2.928	22.00	2.249
2	Giza 93 x Giza 71	3.08	4.658	1.709	36.66	3.51	47.66	35.91	86.25	10.05	2.950	20.80	2.090
3	Giza 92 x Pima H.G.O	3.06	4.219	1.537	36.42	3.49	47.25	36.91	86.58	10.89	2.682	21.31	2.320
4	Giza 96 x Giza 45	3.06	3.687	1.280	34.78	3.55	47.24	36.59	86.76	10.50	2.407	21.62	2.268
5	Giza 96 x Giza 93	3.04	4.388	1.589	36.20	3.49	44.69	36.93	86.54	9.41	2.798	22.30	2.096
6	Giza 88 x Pima H.G.O	3.04	3.825	1.389	36.30	3.56	45.16	36.93	86.90	9.88	2.436	21.79	2.154
7	G.93x{G.87x[G84x(G70xG.51B)]}	2.99	4.213	1.515	35.95	3.63	45.10	36.84	87.08	9.64	2.698	22.04	2.124
8	G.93x{(G.84xF108)x[(G.84xG.45)xG.45]}	3.01	3.881	1.366	35.17	3.49	45.35	37.05	86.90	9.98	2.515	21.84	2.179
9	G.96x{(G.84xF.108)x[(G.84xG.45)xG.45]}	3.00	4.223	1.556	36.85	3.63	44.35	36.25	86.55	10.11	2.667	19.40	1.961
10	Giza 93 x Giza 87	2.97	3.992	1.427	35.76	3.39	48.61	37.38	86.90	9.81	2.565	23.65	2.320
11	Giza 93 x Giza 88	3.00	4.596	1.570	34.16	3.63	47.28	36.78	87.91	9.73	3.026	23.09	2.250
12	Giza 92 x Pima S_1	3.03	4.189	1.502	35.90	3.43	45.05	37.18	86.96	10.68	2.687	21.95	2.344
13	G.93 x [G.76 x (G.45 x S.I.)]	2.98	3.937	1.377	34.97	3.60	45.10	35.88	86.74	9.50	2.560	24.09	2.287
14	Giza 87	3.04	3.382	1.134	33.61	3.22	48.58	37.13	86.76	9.82	2.248	21.9	2.151
15	Giza 88	3.01	3.487	1.305	37.40	3.68	45.36	35.93	86.61	9.99	2.183	21.66	2.162
16	Giza 92	3.06	4.193	1.467	34.96	3.39	46.69	35.16	86.90	10.15	2.727	23.42	2.378
17	Giza 93	3.02	3.760	1.306	34.74	3.71	48.34	35.85	87.18	9.94	2.454	21.88	2.189
18	Giza 96	3.05	4.123	1.567	37.93	3.42	46.21	36.48	87.31	9.98	2.556	21.13	2.109
L.S.D 0.05		0.06	0.405	0.151	0.61	0.114	0.96	0.67	1.07	0.32	0.256	0.68	0.110
L.S.D 0.01		0.08	0.539	0.201	0.81	0.152	1.28	0.89	1.43	0.42	0.339	0.91	0.147

Lint yield/ Plot (Kg): (LY/P.) ranged from 1.134 Kg obtained by Giza 87 variety (genotype 14) to 1.709 Kg obtained by genotype 2 (Giza 93 x Giza 71). Generally, genotypes may be divided into three groups according to their yielding potentiality with significant differences among them; the first group contained 4 genotypes (1, 5, 11 and 14) with the highest LY and significantly surpassed the other genotypes. On the contrary, two genotypes (1 and 4) yielded the lowest LY with significant differences between them and the rest of genotypes. The rest of genotypes showed intermediate values in this respect.

Lint percentage: (L%) ranged from 33.61% for Giza 87 variety (genotype 14) to 37.93 given by Giza 96 variety (genotype 18). Generally, genotypes may be divided into three groups according to their L% with significant differences among them, the first group contained two genotypes (15 and 18) that gave the highest values and significantly surpassed the other genotypes. Whereas two genotypes (11 and 14) had the lowest values with significant differences between them and the other genotypes. The rest of genotypes showed intermediate L% values.

Fiber traits

Fiber fineness: (FF) expressed as micronaire reading for the 18 cotton genotypes were statistically varied and ranged from 3.71 (less fineness) for genotype 17 (Giza 93) to 3.22 (highest fineness) for the genotype 14 (Giza 87) that was significantly different from the rest of genotypes, on the other hand, six genotypes (7, 9, 11, 13, 15 and 17) showed the highest values of micronaire reading with insignificant differences among them and ranked last in fiber fineness. The rest of genotypes showed intermediate values in such trait. All the tested genotypes had fine fibers according to A.S.T.M., D-1776-1998 that grouped fibers as their micronaire reading to very fine with reading ≤ 3 while fine fibers have 3.1 – 3.9 micronaire reading.

Fiber Strength: (FS, g/tex) ranged from 44.35 g/tex for the genotype 9 "G.96 x {(G.84 x F.108) x [(G.84 x G.45) x G.45]} " to 48.61 g/tex for the genotype 10 (Giza 93 x Giza 87). Genotypes may be divided in their FS into three groups with significant differences among them, first comprised three genotypes (10, 14 and 17) that gave the highest values and significantly surpassed the other genotypes. Whereas, six genotypes (5, 6, 7, 9, 12 and 13) gave the lowest values with significant differences between them and the rest of genotypes. The rest of genotypes were intermediate in this respect. Generally, according to A.S.T.M., D-1776-1998, that defined high strength fibers with over 30 g/tex, all the studied genotypes had very strong fibers.

Fiber Length: (FL, mm) for the studied extra-long staple genotypes ranged from 35.16 mm for genotype 16 (Giza 92) that significantly had the shortest fibers than the other genotypes, whereas genotype 10 (Giza 93 x Giza 87) showed the highest FL value (37.38 mm). Nine genotypes (3, 5, 6, 7, 8, 10, 11, 12 and 14) significantly surpassed the other genotypes in FL with insignificant differences among them. The rest of genotypes were intermediate between the aforementioned two groups of genotypes in FL.

Length Uniformity Index: (LU%), cotton genotype with a low length uniformity index has a high variance in fiber length that can make handling difficult and finally result in lower yarn quality. Data in Table 2 showed that LU% varied from 86.25% for the genotype 2 (Giza 93 x Giza 71) that significantly had the lowest value as compared to the other genotypes, whereas the genotype 11 (Giza 93 x Giza 88) had the highest value (87.91%). Nine genotypes (6, 7, 8, 10, 11, 12, 15, 16 and 18) significantly surpassed the other genotypes in LU% with insignificant differences among them. The rest of genotypes showed intermediate values in this respect. A.S.T.M., D-1776-1998, defined LU% more than 86 is considered as very high, accordingly, all the tested genotypes had very high length uniformity index.

Cottonseed Traits

Seed index: (SI), mean SI varied from 9.41 g for the genotype 5 (Giza 96 x Giza 93) to 10.89 g for cotton genotype 3 (Giza 92 x Pima H.G.O) followed by genotype 12 (Giza 92 x Pima S_1) with insignificant differences

between both genotypes, however, the two genotypes significantly excelled the rest of genotypes (except genotype 4) in SI by having bigger seeds which may be ascribed to the exotic germplasm included in their constitution. However, the lowest and significant seed index was observed in three genotypes 5, 7 and 13 that having SI ≤ 9.50 g with insignificant differences between them, whereas the highest seed index (exceeded 10 g) was recorded by seven genotypes 1, 2, 3, 4, 9, 12 and 16 which showed bigger seed with significant differences among them. The rest of genotypes had intermediate SI (10≤ SI ≥ 9.50 g) with significant differences among these genotypes.

Seed yield/ Plot (Kg): (SY/P.) ranged from 2.183 Kg for the genotype 15 (Giza 88), to 3.026 Kg for the genotype 11 (Giza 93 x Giza 88). Four genotypes gave the highest seed yield and surpassed 2.700 Kg/ plot (1, 2, 5 and 11) and did not differ significantly followed by genotype 16 with significant differences between it and the last genotypes. Whereas, four genotypes (4, 6, 14 and 15) gave the lowest seed yield/ plot and did not reach 2.440 Kg and ranked last in seed yielding ability. The rest 9 genotypes were intermediate in seed yield as they exceeded 2.450 Kg/plot but did not reach 2.700 kg/ plot.

The higher yielding genotypes in SCY were also the highest genotypes in seed yield but with different ranking according to their variability in their ginning outturn (L%), which mean that selection for high seed cotton yield might be also improve cottonseed yield.

Seed Oil content: (Oil%) data presented in Table (2) showed that the lowest value of oil content (19.40 %) was attained by genotype 9 (G.96 x{(G.84 x F.108) x [(G.84 x G.45) x G.45]}) that was significantly lower than the other genotypes, whereas the highest oil content (24.09 %) was achieved by the genotype 13 "G.93 x [G.76 x (G45 × sea Island)]", followed by two genotypes 10 and 16 (Giza 93 x Giza 87) and Giza 92, the three genotypes did not differ significantly. The rest of genotypes showed significant differences among them and occupied intermediate rank in oil%.

However, the studied genotypes showed high level of variability in their oil content and could be divided into four groups, first group with high oil content included three genotypes (10, 13 and 16) followed by one genotype (11), the second group had moderately high oil content and included 11 genotypes (1, 3, 4, 5, 6, 7, 8, 12, 15, 17 and 18), the third group that had moderately low oil content included two genotypes (2 and 14), the fourth group comprised only one genotype (9) that ranked last and gave the lowest value of seed oil content.

Seed Oil Index: (OI) which is the weight of oil in 100 seeds, was significantly varied among the tested genotypes, the lowest mean value of OI (1.961 g) was attained by genotype 9 (G.96 x{(G.84 x F.108) x [(G.84 x G.45) x G.45]}) that was significantly lower than the other genotypes, whereas the highest OI (2.378 g) was achieved by the genotype 16 (Giza 92). However, the studied genotypes showed high level of variability in their oil index and the highest OI were given by five genotypes (3, 10, 12, 13 and 16). Whereas only one genotype (9) that ranked last and gave the lowest OI.The rest of genotypes were intermediate in this respect.

Our results were in agreement with the previous works that recorded considerable genetic differences among cotton genotypes for most of plant attributes in *G. hirsutum* (Hinze *et al*., 2015, Vekariya *et al*., 2016, Shakeel *et al*., 2018 and Iqbal *et al*., 2020), and in *G. barbadense* (Mohamed-Amal *et al*., 2010, Ahmad and Hassan, 2014, Abd El-Moghny *et al*. 2015, Shakr *et al*., 2017, Mabrouk, 2020 and Lamlom *et al*., 2020).

Variance components:

Variance components estimated from ANOVA were used for measuring variability that comprised phenotypic and genotypic variance, coefficient of phenotypic (PCV) and genotypic (GCV) variability, broad sense heritability and expected gain with the selection of 10% of the best plants in the population for the studied traits (Table 3).

Phenotypic and genotypic variances for cotton genotypes showed wide variability in productivity traits, as it ranged from 0.0046 and 0.0011 for Vp and Vg, respectively in boll weight to 1.8411 and 1.3429, respectively in lint%. While for fiber traits Vp and Vg ranged from 0.0292 and 0.0181, respectively in fiber fineness to 5.1819 and 1.7297, respectively in fiber strength. With respect to seed traits, Vp and Vg varied from 0.0364 and 0.0117, respectively in oil index to 3.1435 and 1.1878, respectively in oil content %.

Data concerning PCV and GCV shown in Table 3 cleared that values ranged in yield and yield component traits from 2.243% and 0.684%, respectively in boll weight to 15.702 and 9.673, respectively for lint yield. For fiber traits PCV and GCV ranged from 1.556 and 0.462, respectively in length uniformity index to 4.849 for PCV and 3.817 for GCV in fiber fineness. Regarding seed traits PCV and GCV ranged from 4.886 and 3.812, respectively in seed index to 14.803 and 8.727, respectively in seed yield.

Table 3. Genetic parameters estimated in 18 cotton genotypes for the studied traits

Parameter	Yield and yield component traits				Fiber traits				Seed Traits			
	BW (g)	SCY (kg)	LY (kg)	L %	FF Mic.	FS g/tex	FL mm	LU %	SI (g)	SY (kg)	Oil %	OI (g)
Vp	0.0046	0.3651	0.0520	1.8411	0.0292	5.1819	0.8868	1.8227	0.2394	0.150	3.1435	0.0364
Vg	0.0011	0.1268	0.0197	1.3429	0.0181	1.7297	0.4374	0.1610	0.1458	0.052	1.1878	0.0117
PCV	2.243	14.855	15.702	3.803	4.849	4.919	2.581	1.556	4.886	14.803	8.059	8.669
GCV	0.684	8.752	9.673	3.248	3.817	2.8424	1.812	0.462	3.812	8.727	4.954	4.913
H^2_b	24.19	34.71	37.95	72.94	61.97	33.38	49.32	8.83	60.874	34.75	37.79	32.11
GS	1.12	10.62	12.28	5.71	6.19	3.38	2.62	0.28	6.13	10.60	6.27	5.73

Vp: Phenotypic variance, Vg: genotypic variance, PCV: Phenotypic coefficient of variation, GCV: genotypic coefficient of variation, h^2_b: broad sense heritability, GS: expected genetic advance under selection as percent of the mean.

According to Sivasubramanian and Menon (1973), PCV and GCV were classified as: low, moderate and high (<10 %, 10-20 % and >20%). Hence, moderate PCV values were recorded for seed and lint cotton yields as well as seed yield, while the rest of traits showed low PCV values. On the other hand, GCV showed low values in all studied traits.

Moderate to low GCV and PCV recorded for the studied traits suggested the difficulty of manipulating these traits through plant breeding.

GCV was near in magnitude to PCV for some traits (lint%, fiber fineness and seed index), indicating that variation could be largely ascribed to genetic causes and less influence of environmental effects, and these traits are governed by additive gene action (Vijayakumar *et al*., 2013). The rest of traits showed wider gaps between PCV and GCV reflecting the contribution of environment in addition to genotypic effects for the expression of these traits. Our results were in accordance with those previously recorded in cotton by: Abd El-Moghny *et al*. 2015, Lokeshkumar and Patil, 2018, Kumar *et al*., 2019, Amer, 2020, Hampannavar *et al*., 2020 and Mabrouk, 2020).

Heritability and genetic advance are useful estimates to clarify the heritable part of variability and to foresee the behavior of genotype to be used in breeding programs to adopt promising genotypes (Soomro *et al*. 2010). In addition, broad-sense heritability (h^2_b) is an estimate of the portion of total variance that ascribed to genetic causes. Single plant selection in early segregating generations may be more efficient for the trait with high heritability value as compared to that with less heritability value. Robinson *et al.*, (1951) classified heritability values as low: 0-30%, moderate: 30-60% and high: 60% and above. In the studied genotypes, h^2_b recorded low values for boll weight and length uniformity index. Whereas h^2_b values were high for the traits: lint%, fiber fineness and seed index. The rest of traits in showed moderate h^2_b values.

The high values of broad-sense heritability recorded for some traits in this study indicating that such traits had relative small contribution of the environmental factors to the phenotype and heritability is due to the genetic effects and selection could be effective in early segregating generations for improving these traits. Many other researchers found high to moderate broad sense heritability in cotton genotypes for different plant attributes (Abd El-Moghny *et al*. 2015, Campbell *et al*., 2016**,** Amer *et al*., 2019, Kumar *et al*., 2019 and Hampannavar *et al*., 2020).

Expected genetic advance under selection refers to the improvement of traits in genotypic value for the new population as compared to the base population after one cycle of selection at given selection intensity (Singh, 2001). The genetic advance as percent of the mean (G.S%) was classified according to Johanson *et al*., (1955) as: low, moderate and high (<10%, 10 - 20% and >20%, respectively). Data concerning expected genetic advance from selecting the best 5% of the population that presented in Table 4 showed that none of the studied traits showed high G.S%, while moderate values of G.S% were recorded for the traits seed cotton yield, lint yield and seed yield, whereas the rest of traits showed low values of G.S%.

Johanson *et al.* (1955) stated that high heritability values along with high genetic advance percent of the population mean (GS%) is more efficient in predicting gain under selection as compared to heritability alone. In this study, high heritability coupled with high and/or moderate genetic advance were not recorded by any trait, and hence selection in next generation based on these traits would be ineffective. The moderate values of heritability and moderate or low genetic advance recorded for most of the studied traits indicated non additive gene effects and suggesting that simple selection for improving these traits is limited. These traits might be exploited through hybrid breeding. Our results were in the same line with those previously reported by**:** Lokeshkumar and Patil, 2018, Amer *et al*., 2019, Kumar *et al*., 2019, Amer, 2020, Hampannavar *et al*., 2020 and Mabrouk 2020**.**

Correlation between seed traits and the other traits:

Knowledge about correlations between different cotton traits allow determining the extent of relationship among traits and define the trait that will guide the selection, to improve yield, and fiber properties and seed quality.

The simple correlation coefficients between the studied quantitative traits based on combined data across two years were presented in Table (4).

Table 4. Correlation coefficients of various traits in 18 Egyptian cotton genotypes

Traits	BW	SCY	LY	L%	FF	FS	FL	LU	SI	SY	Oil%
SCY	0.235**	1.000									
LY	0.219**	0.943 **	1.000								
L%	-0.003	0.131	0.451 **	1.000							
FF	-0.426**	0.006	0.081	0.269**	1.000						
FS	0.174 *	-0.145	-0.265**	-0.429**	-0.317**	1.000					
FL	-0.192 *	-0.051	-0.071	-0.079	-0.330**	0.024	1.000				
LU	-0.380 **	0.041	-0.055	-0.246**	0.200*	0.157	0.150	1.000			
SI	0.496 **	0.026	0.056	0.105	-0.176*	0.139	0.045	-0.208**	1.000		
SY	0.231 **	0.979 **	0.855 **	-0.073	-0.040	-0.063	-0.038	0.098	0.006	1.000	
Oil%	-0.340**	-0.043	-0.213 **	-0.491**	-0.143	0.201*	-0.022	0.342**	0.387**	0.063	1.000
OI	0.049	-0.030	-0.179 *	-0.421**	-0.276**	0.327**	0.004	0.201*	0.386**	0.063	0.700**

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

The results showed positive highly significant correlations between boll weight and each of, seed cotton, lint and seed yields as well as seed index, while significant positive correlation was recorded with fiber strength. On the contrary, significant negative correlations were found between boll weight and each of fiber fineness, fiber length, length uniformity index and seed oil content.

Seed cotton yield had positive highly significant correlation with lint yield and seed yield. Lint yield exhibited positive highly significant correlation with lint% and seed yield, whereas, correlation was negative and significant with fiber strength, seed oil content and seed oil index. Lint % had positive highly significant correlation only with fiber fineness and negative fiber strength, length uniformity index, seed oil content and seed oil index.

Regarding fiber traits, fiber fineness showed negative significant correlation with fiber strength, fiber length, seed index and seed oil index. Fiber strength showed

significant and highly significant positive correlations with seed oil content and seed oil index, respectively. Length uniformity index exhibited significant and highly significant positive correlations with seed oil index and seed oil content, respectively. Seed index was highly significant correlated with both seed oil content and seed oil index.

Similar significant positive or negative correlations between oil content in cottonseed and other plant attributes were obtained by Ashokkumar and Ravikesavan, 2011, Munawar and Malik, 2013, Abd El-Moghny *et al*. 2015, Hinze *et al*., 2015, Kothari *et al*., 2016 and de Carvalho *et al*., 2017.

To sum, selection for high yield potential may be achieved throughout selection for boll weight and lint %, while fiber traits must be selected separately for each trait. Seed oil content and seed oil index may be improved throughout selection for seed index, fiber strength and length uniformity index in cotton breeding program.

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نسبة الزيت والمحصول وجودة التيله لبعض التراكيب الوراثية فى القطن المصرى

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أقيمت هذه الدراسة بهدف تقدير التباين الوراثى ودرجة الارتباط لصفات محتوى الزيت فى بذور بعض التراكيب الوراثية للقطن المصرى فائقة الطول وعلاقتها بالمحصول وصفات جودة التيلة ووراثة هذه الصفات ومحاولة الانتخاب لتحسين نسبة الزيت مع المحصول العالى من القطن الشعر والصفات التكنولوجية العالية. ولتحقيق هذا الهدف تمت زراعة ثمانية عشر تركيب وراثى منها خمسة أصناف وثلاثة عشر من السلالات فائقة الطول المبشرة من القطن المصرى بمزرعة محطة التجارب الزراعية بسخا بمحافظة كفر الشيخ خلال مواسمين زراعيين (٢٠١٨ ، ٢٠١٩م). تمت زراعة التراكيب الوراثية فى تصميم قطاعات كاملة العشوائية فى أربعة مكررات وتم دراسة الصفات التالية: متوسط وزن اللوزة بالجرام، محصول القطعة التجريبية من القطن الزهر والشعر والبذرة بالكيلوجرام، تصافى الحليج، معدل البذرة، الى جانب الصفات التكنولوجية وتشمل النعومة، المتانه، الطول ومعدل انتظام الطول، كما تم دراسة صفات محتوى الزيت فى البذور من خلال صفتين هما نسبة الزيت فى البذور ومعدل الزيت وهو وزن الزيت الموجود فى ١٠٠ بذرة بالجرام. أظهرت النتائج المتحصل عليها ما يلى: وجود فروق عالية المعنوية بين التراكيب الوراثية تحت الدراسة لكل الصفات المدروسه. كما اختلفت الصفات معنويا من موسم لآخر كما أن التفاعل بين التراكيب الوراثية والسنوات كان معنويا لبعض الصفات.تم تقسيم التراكيب الوراثية تحت الدراسة الى أربعة مجموعات تبعاً لمحتوى الزيت فى البذور وهى: تراكيب ذات محتوى عالى من الزيت، تراكيب ذات محتوى عالى نسبياً، تراكيب ذات محتوى منخفض نسبياً وتراكيب ذات محتوى منخفض من الزيت. أظهرت النتائج معنوية عالية للتباين الكلى والوراثى لكل الصفات المدروسة بما يعكس الاختلاف بين هذه التراكيب الوراثية تحت الدراسة. أعطى معامل التباين المظهرى قيماً متوسطه لصفات محصول القطن الزهر والشعر ومحصول البذرة، بينما كانت القيم منخفضه لباقى الصفات، وقد كانت قيم معامل التباين الوراثى منخفضه لكل الصفات. أعطت القيمه الوراثية قيماً عالية لصفات تصافى الحليج ونعومة التيله ومعدل البذرة مما يدل على امكانية الإنتخاب المباشر لهذه الصفات فى برامج التربية . لم تعطى اى من الصفات المدروسة قيماً عالية من التحسين المتوقع نتيجة إنتخاب ٥٪ أعلى من المتوسط العام للصفة. أظهرت صفتا نسبة الزيت فى البذور ومعدل الزيت إرتباط موجب عالى المعنوية مع الصفات معدل البذرة، متانة التيلة ومعدل إنتظام الطول مما يشير إلى أن الانتخاب ربما يكون مفيد لتحسين صفات الزيت من خلال الإنتخاب للصفات المرتبطة فى برامج التربية. بينما كان الإرتباط معنوى وسالب مع صفات محصول القطن الشعر وتصافى الحليج. كما إرتبطت صفة نسبة الزيت فى البذور إرتباط معنوى سالب مع متوسط وزن اللوزة بينما إرتبطت صفة معدل الزيت بالبذور إرتباط معنوى سالب مع صفة النعومة مما يشير الى صعوبة تحسين محتوى البذور من الزيت للتراكيب الوراثية المدروسة عن طريق الإنتخاب لهذه الصفات ذات الإرتباط السالب فى برامج التربية. أعطت التراكيب الوراثية " جيزة ٩٣ × [جيزة ٧٦ × (جيزة ٤٥ × سى أيلاند)]"، (جيزة ٩٣ × جيزة ٨٧) والصنف جيزة ٩٢ أعلى محتوى من الزيت فى البذور ويمكن استعمالها لتحسين نسبة الزيت فى برنامج تربية القطن المصرى.