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RESPONSE TO SELECTION FOR LINT YIELD IN F_2 AND F_3 POPULATIONS OF EGYPTIAN COTTON HYBRID

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ABSTRACT

The present study was carried out at Shandaweel Agric. Res. Sta., Sohag, Egypt, during the three summer seasons from 2020 to 2022. Two cycles of pedigree selection (in F_2 generation) and one cycle of pedigree selection (in F_3 generation) for lint yield/plant were achieved in segregating population of Egyptian cotton (G. barbadense L.) hybrid GCV% and PCV% estimates were high for lint yield/plant and accounted for 39.88, 39.91% and 30.85, 30.88% after two cycles (F_2 selection) and one cycle (F_3 selection) of pedigree selection. Broad-sense heritability estimates were very high for all studied traits in F_2 and F_3 selection. The means of selected families after two cycles of F_2 selection for lint yield/plant ranged from 41.90g for family no.176 to 81.90g for family no.162 with an average of 58.13g, while the means of the selected families after one cycle of F_3 selection for the same trait ranged from 57.70 g for a family no.195 to 81.90g for a family no. 162 with an average of 67.51 g. The average response to F_2 selection for lint yield/plant from the better parent was significant ($p<0.01$) and accounted for 13.15%. Six selected families showed significant direct response ranging from 10.25% for family No.190 to 59.43% for family No. 162. While, the mean response to F_3 selection for lint yield/plant from the better parent was significant ($p<0.01$) and accounted for 31.42% compared with 13.15% in F_2 selection. All the ten selected families showed significant direct response ranging from 12.32% for family No.195 to 59.43% for family No. 162. After two cycles of pedigree selection (F_2 selection), the coefficients of phenotypic correlation were significant and positive between lint yield and each of seed cotton yield/plant (0.99), boll weight (0.51), number of bolls/plant (0.96), lint index (0.61) and medium with lint percentage (0.39) and seed index (0.49) and low with micronaire reading (0.07) and fiber length (0.03). Also, after one cycle of F_3 selection we found high positive values of correlation coefficients between lint yield/plant and each of seed cotton yield (0.96), boll weight (0.60) and number of bolls/plant (0.78). This result revealed that all of seed cotton yield, boll weight, number of bolls, seed and lint index were the main contributors to lint yield/plant and the selection for any of these traits could increase lint yield/plant.

Key words: ***Cotton, G. barbadense, pedigree selection, lint yield***.

INTRODUCTION

The main objective for a cotton breeder is to obtain high yielding genotypes with acceptable fiber quality by using many different breeding methods. The traditional pedigree selection is widely applied in cotton. Thus, Feaster and Turcotte (1970) suggested that crossing among varieties and strains followed by selection will probably be the most satisfactory breeding method for varietal improvement in cotton. In addition, Culp and Harrell (1973) stated that any breeding method that increases recombination is desirable. The same authors concluded that removal of undesirable plants or selections of the most desirable ones in early segregating generations may be equally important in the varietal process.

Mahrous and Soliman (2017) found that pedigree selection for seed cotton yield or for boll weight were efficient in isolating high yielding families with large number of bolls. Batzios *et al* (1998) found that the material derived by pedigree selection (PS) was earlier in maturity than the material derived by Honycomb pedigree selection (HC) and Single seed decent (SSD). Abd El Sameea *et al* (2020) studied pedigree selection in two segregating populations of Egyptian cotton, which resulted in five superior families were isolated from pop 1 and significantly exceeded the better parent and bulk sample in lint yield and correlated traits. In pop II, three superior families (No.351, No 169 and No 353) showed significant gain in lint yield of 15.96, 31.17 and 28.07% from the bulk sample, and 27.38, 44.09 and 40.68% from the better parent, respectively. Family No.169, showed significant ($p<0.01$) correlated gain over the better parent by 43.38, 4.15, 27.39 and 22.37% for seed cotton yield/plant, lint percentage, number of bolls/plant and boll weight, respectively. Soliman (2018) found that average observed genetic gain of 10 selected families after two cycles of pedigree selection for lint yield/ plant ranged from 9.08% ($p< 0.01$) for lint index 7 (which involved lint yield, boll weight, number of bolls and earliness index) to 22.73% ($p < 0.01$) for index 2 (involved seed cotton, lint yields and number of bolls). Both of index 5 (involved seed cotton yield and lint index) and index 8 (involved lint yield, seed, lint and earliness indices) ranked the first and, showed significant genetic gain of (17.88 and 15.43%) in lint yield/plant. Mabrouk (2020) studied some selection procedures and found that the direct selection for lint yield and pedigree selection for bolls/plant followed by selection for lint/seed gave desirable actual values and surpassed most indices. Selection index involving lint yield/plant and boll/plant surpassed all selection procedures for predicted gain followed by Selection index involving lint yield/plant, bolls/plant, seeds/boll and lint/seed. However direct selection for lint yield followed by pedigree selection for bolls/plant appeared to be most effective for the improvement lint yield and gives reasonable actual gains. The predicted and actual advances determined from F_3 generation were higher than F_4 generation for most selection procedures. On the basis of various selection procedures, six selected families were isolated from F_4 generation by superiority of these

families from better parents, F_3 families and point start of F_2 plants mean. Mahdy *et al* (2007) and Mahrous (2004), after two cycles of pedigree selection found good improvement in the observed gain in seed cotton yield in percentage from the better parent. Mahdy *et al* (2009 a and b) and Mahdy *et al* (2001 a and b) studied some selection procedure and resulted in effective pedigree selection method in isolating of elite genotypes in yield and fiber traits.

Mohamed (2001) found that sufficient genetic variability for further cycles of selection for seed cotton yield/plant. Khan *et al* (2009) reported broad sense heritability estimates of 0.98 for seed cotton yield/plant, 0.96 for boll weight and 0.96 for number of bolls/ plants. Yahia and Hassan (2015) found that the phenotypic coefficient of variation values (PCV) were higher than genotypic coefficient of variation (GCV) for yield and its components. The correlation coefficient between yield and any trait is reflected from direct effect of that trait which will help for identifying the trait that contribute directly to improve lint yield. Fonseca and Paterson (1968) found that correlation coefficient analysis measures the magnitude of relationship between various plant traits on which selection can be based for improvement in plant yield. The present work aimed to study and compare the efficiency of pedigree selection for lint yield/plant to isolate superior families in yield and its components in F_2 and F_3 generations of an Egyptian cotton hybrid.

MATERIALS AND METHODS

The present study was carried out at Shandaweel Agricultural Research Station, Sohag, Egypt during the period from 2020 to 2022 summer seasons. The breeding material used in this study was 200 F_2-plants stemmed from the cross between ((Giza 90 x Giza 91) x Giza 80) and Giza-95. The population was subjected to pedigree selection for two cycles (F_2 selection) and one cycle (F_3 selection) for lint yield/plant.

In 2020 season, the 200 F_2- plants with the two parents were sown on 27th of March in individuals plants. After full emergence, seedlings were thinned at one plant per hill, 40 cm between hills. The recommended cultural practices were adopted throughout the growing season. The recorded traits were, seed cotton yield/plant, lint yield/plant, lint percentage,

boll weight, number of bolls/plant, seed index, lint index, micronaire reading, pressley index, fiber length and uniformity ratio. At the end of season 2020, the 30 superior plants in lint yield/plant were selected and saved for the next season (F_2 selection).

In season 2021, all the 30 selected and non-selected families along with the two parents were sown on 1st of April using a randomized complete block design with three replications. Each plot was a single row 4 m long, 60 cm apart, 40 cm between hills within a row. The best plant from each of the ten superior families from the selected families of lint yield/plant was selected (F_2 selection) and saved for the next season. Also, the best plant from each of the ten superior families from the selected and non-selected families (F_3 selection) was selected and saved for the next season.

In season 2022, sowing date was on 27th of March, the same experimental design and field procedure were as the previous season. The ten selected families with two parents were planted to evaluate the two cycles of F_2 direct selection and one cycle of the F_3 direct selection for lint yield/plant.

Statistical analysis

Data were subjected to proper statistical analysis according to Steel and Torrie (1960) Genotypes means were compared using revised least significant Difference test (R L S D) according to El-Rawi and Khalafalla (1980). The phenotypic (σ^2_P), genotypic (σ^2_g) variances, and heritability in broad sense(H) were calculated according to Walker (1960).

The phenotypic (PCV) and genotypic (GCV) coefficient of variability were calculated as outlined by Burton (1952). Phenotypic correlation coefficients were calculated as described by Johan son *et al* (1955).

RESULTS AND DISCUSSION

Characterization of the base population (season 2020)

Means of all studied traits for all single plants in the F_2-population are presented in Table (1). The data showed a wide range in all studied traits, where, seed cotton yield/plant ranged from 10 g to 243.8 g with a mean of 99.62 g with high value of the coefficient of variation of 58.84%,

while for lint yield/plant ranged from 3.9 g to 89.8 g, with an average of 38.74 g and a high value of the coefficient of variation of 59.01%.

Table 1. Description of the base population in the F_2-generation.

Items	Studied traits						
	Seed cotton yield/plant, g	Lint yield/plant, g	Lint%	Boll weight, g	No. of bolls/plant	Seed index, g	Lint index, g
Mean ± SE	99.62 ±6.76	38.74 ±2.63	38.97 ±0.29	2.56 ±0.06	39.01 ±2.66	9.35 ±0.18	4.02 ±0.08
Min.	10	3.9	30.94	1.78	5	7.10	2.57
Max.	243.8	89.8	41.87	3.44	95.13	11.10	4.95
C.V.%	58.84	59.01	13.47	19.14	57.51	16.27	17.66

Lint percentage ranged from 30.94% to 41.87% with a mean of 38.97%, and low value of the coefficient of variation of 13.47%, and boll weight ranged from 1.77 g to 3.44g with a mean of 2.56 g and the coefficient of variation showed a medium value and reached to 19.14%, while number of bolls/plant ranged from 5 to 95.13 with an average of 39.01, and the coefficient of variation showed a high value reached to 57.51%. Means of seed index and lint index ranged from 7.10, 2.57 g to 11.10, 4.95 g with an average of 9.35, 4.02 g, with a medium value of coefficient of variation which reached to 16.27, 17.66%, respectively. These results indicated a wide range in means of all studied traits accompanied with high values of coefficients of variation for seed cotton yield, lint yield and number of bolls. These results are in agreement with those found by Mahdy *et al* (2009 a and b), Mahdy *et al* (2012), Mahrous and Soliman (2017) and Soliman (2018).

Effect of the selection procedures on the variability and heritability

The analysis of variance, genotypic and phenotypic coefficients of variation and broad-sense heritability estimates after two cycles and one cycle of pedigree selection are presented in Table 2. Genotypes mean squares of lint cotton yield and all the studied traits were highly significant in both of F_2 and F_3 selection. These results indicated the presence of variability in the criteria of selection. The PCV and GCV% were high and accounted for 39.91 and 39.88% in F_2 selection, while, accounted for 30.88 and 30.85% in F_3 selection for lint yield/plant, indicating a sufficient genetic variability for further cycles of selection for lint yield/plant.

Table 2. Mean squares, phenotypic (PCV), genotypic (GCV) coefficients of variability and broad-sense heritability estimates (H_b) of the selected families after two cycles (from F_2) and one cycle (from F_3) of pedigree selection for all the studied traits.

SOV	df	Seed cotton yield		Lint yield		Lint percentage	
		Early	Late	Early	Late	Early	Late
Replications	2	1.37	1.91	1.38	1.48	0.501	0.82
Genotypes	11	3331.14**	2715.84**	537.35**	434.01**	5.161**	4.49**
Error	22	4.56	4.80	0.73	0.77	0.231	0.183
PCV%		38.20	30.03	39.91	30.88	6.04	5.56
GCV%		38.17	30.00	39.88	30.85	5.91	5.45
H_b		99.92	99.90	99.92	99.90	97.84	98.02
SOV	df	Boll weight		No. of Bolls		Seed index	
		Early	Late	Early	Late	Early	Late
Replications	2	0.008	0.004	1.096	0.546	0.033	0.058
Genotypes	11	0.082**	0.111**	255.34**	187.04**	0.278**	0.195**
Error	22	0.003	0.003	1.45	1.31	0.009	0.009
PCV%		9.15	10.30	33.93	25.88	5.35	4.52
GCV%		8.97	10.15	33.84	25.81	5.26	4.42
H_b		98.03	98.54	99.73	99.73	98.32	97.79
SOV	df	Lint index		Micronaire reading		Presseley index	
		Early	Late	Early	Late	Early	Late
Replications	2	0.024	0.041	0.003	0.001	0.003	0.001
Genotypes	11	0.426**	0.436**	0.089**	0.116**	0.658**	0.56**
Error	22	0.019	0.016	0.002	0.003	0.002	0.003
PCV%		10.69	10.55	6.93	8.10	8.16	7.52
GCV%		10.46	10.36	6.83	8.00	8.15	7.49
H_b		97.85	98.20	98.56	98.77	99.88	99.60

SOV	df	Fiber length		Uniformity ratio	
		Early	Late	Early	Late
Reps.	2	0.384	0.95	0.101	0.367
Geno.	11	2.474**	3.298**	6.078**	2.064**
Error	22	0.284	0.268	0.328	0.357
PCV%		5.34	6.08	2.98	1.86
GCV%		5.05	5.85	2.91	1.71
H_b		94.57	96.22	97.66	91.94

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

The GCV and PCV% estimates were high for seed cotton yield/plant and number of bolls/plant, and intermediate for boll weight, lint index and presseley index and low for other studied traits after two cycles (F_2 selection) and one cycle (F_3 selection) of pedigree selection. In general, coefficient of variability estimates in F_3 selection were less than in F_2 selection in most of the studied traits. These results suggested that practiced selection gain in F_3 generation reduce the differences between the plants within families. Broad-sense heritability estimates were very high for all studied traits in F_2 and F_3 selection. Mahrous and Soliman (2017) found that the GCV estimates after two cycles of pedigree selection for seed cotton yield and boll weight accounted for 34.16 and 36.95% for seed cotton yield, and 16.47 and 10.36% for boll weight in population I and II, respectively. heritability showed high estimates for all studied traits in the populations. Mahrous (2004) found high estimates of GCV in seed, lint cotton yield/plant and number of bolls/plant after two cycles of pedigree selection for seed cotton yield/plant. Mahdy *et al* (2012) reported that after two cycles of pedigree selection for earliness index and lint yield, the remained GCV were 22.59 and 21.50% for lint yield in pop.I and II, respectively.

Response to selection

Means of the selected families

Means of the 10 superior families after two cycles of F_2 selection, as well as after one cycle of F_3 selection for lint yield/plant are presented in Tables (3 and 4). Looking for the results in tables we found that, the means of selected families after two cycles of selection (in F_2) for the criteria of selection lint yield/plant ranged from 41.90 g for family no.176 to 81.90 g for family no.162 with a mean of 58.13 g, while the means of the selected families after one cycle of selection (in F_3) for the same trait ranged from 57.70 g for family no.195 to 81.90 g for family no. 162 with an average of 67.51 g. These results showed that mean of the selected families after one cycle was higher than the mean of the selected families after two cycles, this increase may be due to the delay in selection for a one generation, which led to an increase in homozygosity of trait.

Table 3. Means of the selected families after two cycles of selection (in F_2) for lint yield/plant.

Families	SCY, g	LYP, g	Lint%	BW, g	BN	SI, g	LI, g	MR	PI	FL, mm	UR
32	178.30	71.73	40.23	3.51	50.86	10.53	7.09	4.43	10.22	31.93	84.70
66	135.17	50.47	37.34	3.30	40.96	9.63	5.74	4.40	9.44	32.10	86.40
137	146.43	58.87	40.20	3.09	47.47	9.64	6.48	4.51	10.21	30.70	84.57
138	164.90	64.40	39.05	3.03	54.39	10.18	6.52	4.39	10.11	30.33	82.60
154	130.47	47.97	36.76	3.06	42.65	10.33	6.01	4.36	10.36	31.20	85.50
162	212.60	81.90	38.53	3.33	63.78	10.13	6.35	4.16	9.31	31.60	83.43
176	105.03	41.90	39.90	3.02	34.85	9.52	6.32	4.21	9.01	31.33	85.47
182	169.40	64.43	38.04	3.14	53.90	9.97	6.12	4.45	10.09	29.63	83.70
183	118.33	42.97	36.31	3.21	36.88	9.93	5.66	4.24	10.30	30.67	84.77
190	151.27	56.63	37.44	3.26	46.45	10.24	6.13	4.42	10.43	31.37	87.33
Mean	151.19	58.13	38.38	3.19	47.22	10.01	6.24	4.36	9.95	31.09	84.85
P.1	136.00	51.37	37.78	3.22	42.19	10.02	6.09	3.93	9.55	29.17	82.77
P.2	92.03	35.57	38.65	2.91	31.67	9.84	6.20	4.10	9.88	30.13	83.93
M.P.	114.02	43.47	38.21	3.06	36.93	9.93	6.15	4.01	9.72	29.65	83.35
RLSD0.05	3.16	1.27	0.73	0.08	1.78	0.14	0.21	0.06	0.06	0.84	0.91
RLSD0.01	4.20	1.69	0.97	0.11	2.37	0.19	0.28	0.08	0.08	1.13	1.21

SCY = Seed cotton yield/plant, LYP = Lint yield/plant, BW = Boll weight, BN = No. of Bolls, SI = Seed index, LI = Lint index, MR = Micronaire reading, PI = Presseley index, FL = Fiber length, UR = Uniformity ratio, P.1, ((Giza 90 x Giza 91) x Giza 80), P.2, Giza-95 and M.P., Mid-Parents.

Table 4. Means of the selected families after one cycle of selection (in F_3) for lint yield/plant.

Families	SCY, g	LYP, g	Lint%	BW, g	BN	SI, g	LI, g	MR	PI	FL, mm	UR
32	178.30	71.73	40.23	3.51	50.86	10.53	7.09	4.43	10.22	31.93	84.70
71	176.37	69.20	39.24	3.32	53.07	10.23	6.61	4.25	9.51	29.60	83.40
85	162.97	61.70	37.86	3.09	52.69	9.62	5.86	4.50	10.83	31.70	84.47
93	177.67	72.60	40.86	3.51	50.59	9.82	6.79	4.40	10.12	31.40	83.70
137	146.43	58.87	40.20	3.09	47.47	9.64	6.48	4.51	10.21	30.70	84.57
138	164.90	64.40	39.05	3.03	54.39	10.18	6.52	4.39	10.11	30.33	82.60
162	212.60	81.90	38.53	3.33	63.78	10.13	6.35	4.16	9.31	31.60	83.43
171	190.63	72.57	38.07	3.41	55.90	9.94	6.11	4.31	10.01	31.93	85.40
182	169.40	64.43	38.04	3.14	53.90	9.97	6.12	4.45	10.09	29.63	83.70
195	157.63	57.70	36.60	3.32	47.44	10.03	5.79	3.85	9.41	32.07	84.53
Mean	173.69	67.51	38.87	3.28	53.01	10.01	6.37	4.26	9.98	31.09	84.05
P.1	136.00	51.37	37.78	3.22	42.19	10.02	6.09	3.93	9.55	29.17	82.77
P.2	92.03	35.57	38.65	2.91	31.67	9.84	6.20	4.10	9.88	30.13	83.93
M.P.	114.02	43.47	38.21	3.06	39.44	9.93	6.15	4.01	9.72	29.65	83.35
LSD0.05	3.24	1.29	0.65	0.08	1.69	0.14	0.19	0.08	0.08	0.82	0.99
LSD0.01	4.31	1.72	0.86	0.11	2.25	0.19	0.25	0.11	0.11	1.10	1.34

SCY = Seed cotton yield/plant, LYP = Lint yield/plant, BW = Boll weight, BN = No. of Bolls, SI = Seed index, LI = Lint index, MR = Micronaire reading, PI = Presseley index, FL = Fiber length, UR = Uniformity ratio, P.1, ((Giza 90 x Giza 91) x Giza 80), P.2, Giza-95 and M.P., Mid-Parents.

From the ten selected families after two cycles (F_2 selection), only six families surpassed the better parent in lint yield/plant, while, all the selected families after one cycle (F_3 selection) significantly exceeded the better parent in the same trait. The same trend of observation was found for seed cotton yield/plant and number of bolls/plant in both F_2 and F_3 selection, where, mean seed cotton yield ranged from 105.03g to 212.60g with an average of 151.19g and ranged from 146.43g to 212.60g with an average of 173.69g in F_2 and F_3 selection, respectively. Also, mean number of bolls/plant ranged from 34.85 to 63.78 and from 47.44 to 63.78 in F_2 and F_3 selection, respectively (Tables 3 and 4). The boll weight mean ranged from 3.02g to 3.51g in F_2 selection, and ranged from 3.03g to 3.51g, but the mean of boll weight in F_3 selection was larger than the mean of boll weight in F_2 selection. Also, the selected families in F_3 selection have a larger mean in lint index than the selection in F_2 selection.

Regarding to the technology traits we found that the overall mean of micronaire reading for selected families in F_3 selection was slightly fineness than those of F_2 selection after two cycles of selection. In general, the selected families in F_3 selection were better than in those of F_2 selection. These results are in agreement with those reported by Ali (2012) in sorghum crop who found that pedigree selection in the F_{5-} generation was more efficient than early selection in the F_{3-}generation.

Ismail *et al* (2013) in sesame found that the means of selected families after two cycles of F_2 selection for seed yield/plant ranged from 31.88 to 43.50 with an average of 37.36 compared to 17.83, 25.47 and 23.33g relative to P1, P2 and bulk sample in population I, respectively. Likewise, these means varied from 29.33 to 39.67 with an average of 34.03 compared to their respective parents P1 (19.00) P2 (29.00) and bulk sample (30.0g) in population II. The average of seed yield/plant overall selected families was 41.24 and 42.37 after one cycle of F_3 selection and surpassed their averages of 37.36 and

34.03 g after two cycles of F_2 selection by 10.38 and 24.51% for population I and II, respectively.

Response and correlated response to F_2 and F_3 selection

Response and correlated response to F_2 and F_3 selection for lint yield/plant measured as a percentage of the better parent and the mid-parent are presented in Tables (5-8). The average response to F_2 selection for lint yield/plant compared to the better parent was significant ($p<0.01$) and accounted for 13.15% (Table5). Six selected families showed significant direct response ranging from 10.25% for family No.190 to 59.43% for family No. 162.

The mean correlated response to F_2 selection from the better parent showed significant and highly significant gain of 11.17,11.92, 0.65, 6.23, 0.68, 3.18 and 1.09% for seed cotton yield/plant, number of bolls/plant, lint index, micronaire reading, pressely index, fiber length and uniformity ratio, respectively. Family no.32 significantly exceeded the better parent in all studied traits except uniformity ratio, and family no.190 significantly exceeded the better parent in all studied traits, except lint percentage and lint index.

The direct observed response to F_2 selection for lint yield/plant from the mid-parent (Table 6) ranged from 10.34 to 88.41% for families No.154 and No.162, respectively, with an average of 33.72%. Eight selected families showed significant ($p<0.01$) direct gain from the mid-parent, all these families significantly exceeded the mid-parent in seed cotton yield/plant and number of bolls/plant and in boll weight, except family no. 138 and 154. All the ten selected families significantly surpassed the mid-parent in micronaire reading and fiber length, except family no.182. The elite family no.32 significantly exceeded the mid-parent in all the studied traits, families no. 137, 138, 162, 182 and 190 significantly surpassed the mid-parent in most of the studied traits.

Results in Table 7, showed that the mean response to F_3 selection for lint yield/plant compared to the better parent was significant ($p<0.01$) and accounted for 31.42% compared with 13.15% in F_2 selection. All the ten selected families showed significant direct response ranging from 12.32% for family No.195 to 59.43% for family No. 162.

Table 5. Observed direct and correlated response after two cycles of selection (in F_2) measured in percentage of the better parent.

Families	SCY, g	LYP, g	Lint%	BW, g	BN	SI, g	LI, g	MR	PI	FL, mm	UR
32	31.10**	39.64**	4.09**	8.90**	20.54**	5.06**	14.28**	7.97**	3.44**	5.99**	0.92
66	-0.61	-1.76	-3.40	2.48**	-2.92	-3.93	-7.48	7.32**	-4.45	6.54**	2.94**
137	7.67**	14.59**	4.01**	-4.14	12.52**	-3.76	4.56**	9.92**	3.31**	1.89	0.76
138	21.25**	25.36**	1.04*	-5.80	28.92**	1.56**	5.16**	7.07**	2.33**	0.67	-1.58
154	-4.07	-6.63	-4.88	-4.97	1.09	3.13**	-3.10	6.26**	4.86**	3.55**	1.87**
162	56.32**	59.43**	-0.32	3.52**	51.18**	1.06**	2.36**	1.46**	-5.80	4.88**	-0.59
176	-22.77	-18.43	3.22**	-6.31	-17.39	-4.99	1.92**	2.60**	-8.84	3.99**	1.83**
182	24.56**	25.43**	-1.59	-2.38	27.77**	-0.53	-1.32	8.46**	2.16**	-1.65	-0.27
183	-12.99	-16.36	-6.06	-0.31	-12.59	-0.93	-8.72	3.41**	4.28**	1.78**	1.00*
190	11.23**	10.25**	-3.13	1.14**	10.10**	2.16**	-1.17	7.80**	5.57**	4.10**	4.05**
Mean	11.17**	13.15**	-0.7	-0.79	11.92	-0.12	0.65**	6.23**	0.68**	3.18**	1.09*
LSD0.05	3.62	1.45	0.81	0.09	2.04	0.16	0.23	0.07	0.07	0.90	0.97
LSD0.01	4.92	1.97	1.11	0.13	2.78	0.22	0.32	0.09	0.09	1.23	1.32

SCY = Seed cotton yield/plant, LYP = Lint yield/plant, BW = Boll weight, BN = No. of Bolls, SI = Seed index, LI = Lint index, MR = Micronaire reading, PI = Presseley index, FL = Fiber length, UR = Uniformity ratio, P.1, ((Giza 90 x Giza 91) x Giza 80), P.2, Giza-95 and M.P., Mid-Parents.
*** and **, significant at 0.05 and 0.01 levels of probability, respectively.**

Table 6. Observed direct and correlated response after two cycles of selection (in F_2) measured in percentage of the Mid-parent.

Families	SCY, g	LYP, g	Lint%	BW, g	BN	SI, g	LI, g	MR	PI	FL, mm	UR
32	56.38**	65.02**	5.29**	14.60**	37.71**	6.01**	15.21**	10.39**	5.14**	7.70**	1.62**
66	18.55**	16.10**	-2.29	7.84**	10.91**	-3.05	-6.73	9.73**	-2.88	8.26**	3.66**
137	28.43**	35.42**	5.21**	0.87**	28.55**	-2.89	5.41**	12.39**	5.01**	3.54**	1.46**
138	44.62**	48.15**	2.20**	-0.87	47.28**	2.48**	6.02**	9.48**	4.01**	2.30**	-0.90
154	14.42**	10.34**	-3.78	0.00	15.49**	4.06**	-2.31	8.65**	6.58**	5.23**	2.58**
162	86.46**	88.41**	0.83*	8.93**	72.71**	1.98**	3.20**	3.74**	-4.25	6.58**	0.10
176	-7.88	-3.61	4.41**	-1.42	-5.63	-4.13	2.75**	4.90**	-7.34	5.68**	2.54**
182	48.57**	48.22**	-0.45	2.72**	45.96**	0.37**	-0.52	10.89**	3.84**	-0.06	0.42
183	3.78*	-1.16	-4.97	4.90**	-0.14	-0.03	-7.98	5.74**	6.00**	3.43**	1.70**
190	32.67**	30.28**	-2.01	6.43**	25.79**	3.09**	-0.37	10.22**	7.30**	5.79**	4.78**
Mean	32.60**	33.72**	0.44	4.40**	27.86**	0.79**	1.47**	8.61**	2.34**	4.85**	1.80**
LSD0.05	3.13	1.25	0.70	0.08	1.77	0.14	0.20	0.07	0.07	0.78	0.84
LSD0.01	4.26	1.70	0.96	0.11	2.40	0.19	0.27	0.09	0.09	1.06	1.14

SCY = Seed cotton yield/plant, LYP = Lint yield/plant, BW = Boll weight, BN = No. of Bolls, SI = Seed index, LI = Lint index, MR = Micronaire reading, PI = Presseley index, FL = Fiber length, UR = Uniformity ratio, P.1, ((Giza 90 x Giza 91) x Giza 80), P.2, Giza-95 and M.P., Mid-Parents.

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

Table 7. Observed direct and correlated response after one cycle of selection (in F_3) measured in percentage of the better parent.

Families	SCY, g	LYP, g	Lint%	BW, g	BN	SI, g	LI, g	MR	PI	FL, mm	UR
32	31.10**	39.64**	4.09**	8.90**	7.70**	5.06**	14.28**	7.97**	3.44**	5.99**	0.92
71	29.68**	34.71**	1.52**	3.21**	12.39**	2.13**	6.58**	3.58**	-3.71	-1.76	-0.63
85	19.83**	20.11**	-2.05	-3.93	11.59**	-4.03	-5.50	9.84**	9.65**	5.21**	0.64
93	30.64**	41.33**	5.73**	9.11**	7.13**	-1.96	9.49**	7.32**	2.40**	4.22**	-0.27
137	7.67**	14.59**	4.01**	-4.14	0.54	-3.76	4.56**	9.92**	3.31**	1.89**	0.76
138	21.25**	25.36**	1.04**	-5.80	15.19**	1.56**	5.16**	7.07**	2.33**	0.67	-1.58
162	56.32**	59.43**	-0.32	3.52**	35.07**	1.06**	2.36**	1.46**	-5.80	4.88**	-0.59
171	40.17**	41.26**	-1.51	5.90**	18.39**	-0.80	-1.45	-11.06	1.32**	5.99**	1.75**
182	24.56**	25.43**	-1.59	-2.38	14.16**	-0.53	-1.32	8.46**	2.16**	-1.65	-0.27
195	15.91**	12.32**	-5.29	3.21**	0.46	0.13	-6.56	-6.02	-4.76	6.43**	0.72
Mean	27.71**	31.42**	0.56	1.76**	12.26**	-0.11	2.76**	3.85**	1.03**	3.19**	0.14
LSD0.05	3.71	1.48	0.72	0.09	1.94	0.16	0.22	0.09	0.09	0.88	1.01
LSD0.01	5.04	2.01	0.98	0.13	2.63	0.22	0.30	0.13	0.13	1.20	1.38

SCY = Seed cotton yield/plant, LYP = Lint yield/plant, BW = Boll weight, BN = No. of Bolls, SI = Seed index, LI = Lint index, MR = Micronaire reading, PI = Presseley index, FL = Fiber length, UR = Uniformity ratio, P.1, ((Giza 90 x Giza 91) x Giza 80), P.2, Giza-95 and M.P., Mid-Parents.
*** and **, significant at 0.05 and 0.01 levels of probability, respectively.**

Table 8. Observed direct and correlated response after one cycle of selection (in F_3) measured in percentage of the Mid-parent.

Families	SCY, g	LYP, g	Lint%	BW, g	BN	SI, g	LI, g	MR	PI	FL, mm	UR
32	56.38**	65.02**	5.29**	14.60**	28.95**	6.01**	15.21**	10.39**	5.14**	7.70**	1.62**
71	54.68**	59.19**	2.69**	8.61**	34.56**	3.05**	7.44**	5.90**	-2.13	-0.17	0.06
85	42.93**	41.94**	-0.92	1.09**	33.60**	-3.16	-4.74	12.30**	11.45**	6.91**	1.34**
93	55.82**	67.01**	6.95**	14.81**	28.26**	-1.07	10.38**	9.73**	4.08**	5.90**	0.42
137	28.43**	35.42**	5.21**	0.87**	20.37**	-2.89	5.41**	12.39**	5.01**	3.54**	1.46**
138	44.62**	48.15**	2.20**	-0.87	37.91**	2.48**	6.02**	9.48**	4.01**	2.30**	-0.90
162	86.46**	88.41**	0.83*	8.93**	61.72**	1.98**	3.20**	3.74**	-4.25	6.58**	0.10
171	67.19**	66.94**	-0.37	11.44**	41.74**	0.10	-0.65	-9.06	2.98**	7.70**	2.46**
182	48.57**	48.22**	-0.45	2.72**	36.67**	0.37**	-0.52	10.89**	3.84**	-0.06	0.42
195	38.25**	32.74**	-4.20	8.61**	20.28**	1.04**	-5.80	-3.91	-3.19	8.15**	1.42**
Mean	52.33**	55.30**	1.72**	7.08**	34.41**	0.79**	3.60**	6.18**	2.70**	4.86**	0.84
LSD0.05	3.21	1.29	0.63	0.08	1.68	0.14	0.19	0.08	0.08	0.76	0.88
LSD0.01	4.37	1.75	0.85	0.11	2.28	0.19	0.25	0.11	0.11	1.03	1.19

SCY = Seed cotton yield/plant, LYP = Lint yield/plant, BW = Boll weight, BN = No. of Bolls, SI = Seed index, LI = Lint index, MR = Micronaire reading, PI = Presseley index, FL = Fiber length, UR = Uniformity ratio, P.1, ((Giza 90 x Giza 91) x Giza 80), P.2, Giza-95 and M.P., Mid-Parents.
*** and **, significant at 0.05 and 0.01 levels of probability, respectively.**

The correlated gains to F_3 selection from the mid-parent were significant and highly significant and accounted for 27.71, 12.26, 2.76, 3.85, 1.03, 3.19 and 0.14 compared with the mean correlated gains to F_2 selection which accounted for 11.17, 11.92, 0.65, 6.23, 0.68, 3.18 and 1.09% for seed cotton yield/plant, number of bolls/plant, lint index, micronaire reading, pressely index, fiber length and uniformity ratio, respectively. Family no.32 significantly exceeded the better parent in all studied traits, except uniformity ratio, and family no.93 significantly exceeded the better parent in all studied traits, except seed index and uniformity ratio. Families no.137,

138 and 162 surpassed the better parent in all studied traits. The direct observed response to F_3 selection for lint yield/plant from the mid-parent (Table 8) ranged from 32.74 to 88.41% for families no. 195 and 162, respectively, with an average of 55.30%. All the selected families showed significant ($p<0.01$) direct gain compared of the mid-parent, all these families significantly exceeded the mid-parents in seed cotton yield/plant, number of bolls/plant and boll weight, except family no. 138. Eight selected families significantly surpassed the mid-parent in micronaire reading and fiber length.

The elite family no.32 significantly exceeded the mid-parent in all the studied traits. All the families significantly surpassed the mid-parent in most of the studied traits. These results are in agreement with those reported by Mahdy (1983 a and b), who achieved an observed gain in lint yield/plant after two cycles of selection in two populations of 8.4 and 6.3% from the better parent. Mahdy *et al* (1987 a and b) reported that direct observed gain in lint yield/plant exceeded the mid–parent by 32.88%. Soliman (2018) found that after two cycles of pedigree selection for lint yield/plant were accompanied with favorable significant ($P<0.01$) correlated gains from the bulk sample. 29.10% for seed cotton yield /plant 19.59% for number of bolls/plant, 2.74% for lint percentage and 8.23% for boll weight. Likewise, the correlated gain from the better parent as significant ($p<0.01$) for seed cotton yield/plant (24.61) for number of bolls/plant (16.53%), boll weight (-4.32), seed index (-12.49%) and lint index (-11.90%) taking into consideration. The direct gain in lint yield/plant and the correlated gain in seed cotton yield/plant the four promising families were No.329, No.22, No.49 and No.310. Abd El-Sameea *et al* (2020) found that after two cycles of pedigree selection In pop I the direct observed gain was significant ($p<0.01$) from bulk sample (35.67%) and from the better parent (27.83%). Five superior families were isolated from pop 1 and significant exceeded the better parent and bulk sample in lint yield and correlated traits. in pop II, three superior families No.351, No 169 and No 353 showed significant gain in lint yield of 15.96, 31.17 and 28.07% from the bulk sample, and 27.38, 44.09 and 40.68% from the better parent, respectively. Family No.169, showed significant ($p<0.01$) correlated gain from better parent of

43.38,4.15, 27.39 and 22.37% for seed cotton yield/plant, lint percentage, number of bolls/plant and boll weight, respectively.

Phenotypic correlation coefficients

The phenotypic correlation coefficients between pairs of the studied traits after two cycles of F_2 selection are presented in Table (9). After two cycles of pedigree selection (F_2 selection), the coefficients of phenotypic correlation were highly significant and positive between lint yield and each of seed cotton yield/plant (0.99), boll weight (0.51), number of bolls/plant (0.96), lint index (0.61) and medium with lint percentage (0.39) and seed index (0.49) and low with micronaire reading (0.07) and fiber length (0.03), but were high and negative with uniformity ratio (-0.54). Moreover, the phenotypic correlations were increased between seed cotton yield /plant and each of boll weight, number of bolls/plant, seed and lint index, lint percentage and lint index, boll weight and fiber length, seed index and pressely index, micronaire reading and pressely index, and fiber length and uniformity ratio after two cycles of selection.

Also, after one cycle of F_3 pedigree selection we found high and positive values of correlation coefficients between lint yield/plant and each of seed cotton yield (0.96), boll weight (0.60) and number of bolls/plant (0.78). This result revealed that these traits were the main contributors of lint yield/plant and the selection for any of these traits could increase lint yield/plant.

Moreover, seed cotton yield/plant recorded high and positive correlation valueswith each of boll weight and number of bolls/plant, while, recorded medium and positive correlation with seed index, and low with lint index and negative values with each of micronaire reading, pressely index and uniformity ratio. Also, positive and high correlations were found between lint percentage with each of lint index and micronaire reading, high and positive between micronaire reading and pressely index. These results indicated that boll weight, number of bolls and seed index played significant roles in improvement of yield. These results agree with those reported by Abo-Sen (2001), Amein *et al* (2020), Marous and Soliman (2017) and Soliman (2018).

Table 9. Estimation of phenotypic correlation coefficients among studied traits after two cycles of selection in F_2 (above diagonal) and after one cycle of selection in F_3 (blow diagonal) for lint yield/plant.

	SCY	LYP	Lint%	BW	BN	SI	LI	MR	PI	FL	UR
SCY		0.99**	0.25	0.52	0.97**	0.52	0.50	0.04	0.02	0.02	-0.51
LYP	0.96**		0.39	0.51	0.96**	0.49	0.61*	0.07	-0.01	0.03	-0.54
Lint%	0.01	0.30		0.03	0.26	-0.11	0.86**	0.19	-0.28	0.07	-0.33
BWT	0.54	0.60*	0.27		0.31	0.44	0.28	0.01	0.04	0.59	0.16
BN	0.87**	0.78**	-0.16	0.04		0.46	0.47	0.07	0.04	-0.16	-0.62
SI	0.40	0.42	0.11	0.43	0.22		0.42	0.12	0.57	0.09	-0.14
LI	0.17	0.43	0.90**	0.43	-0.05	0.53		0.23	0.04	0.12	-0.37
MR	-0.37	-0.19	0.55	-0.39	-0.19	-0.13	0.41		0.60*	-0.23	0.13
PI	-0.44	-0.35	0.24	-0.33	-0.32	-0.44	0.02	0.54		-0.36	0.05
FL	0.23	0.18	-0.17	0.48	-0.01	-0.04	-0.15	-0.43	0.06		0.54
UR	-0.10	-0.15	-0.18	0.33	-0.33	-0.23	-0.24	-0.43	0.25	0.62*	

SCY = Seed cotton yield/plant, LYP = Lint yield/plant, BW = Boll weight, BN = No. of Bolls, SI = Seed index, LI = Lint index, MR = Micronaire reading, PI = Presseley index, FL = Fiber length, UR = Uniformity ratio, P.1, ((Giza 90 x Giza 91) x Giza 80), P.2, Giza-95 and M.P., Mid-Parents.

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

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الاستجابة للانتخاب لمحصول الشعر فى عشيرة الجيل الثانى والثالث لهجين من القطن المصرى

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اجريت هذه الدراسة فى محطة البحوث الزراعية بشندويل بسوهاج التابعة لمركز البحوث الزراعية خلال ثلاث مواسم صيفية من ٢٠٢٠ الى ٢٠٢٢. تم عمل دورتين من الانتخاب المنسب (الانتخاب فى الجيل الثانى) ودورة واحدة من الانتخاب المنسب (الانتخاب فى الجيل الثالث) لصفة محصول الشعر فى عشيرة انعزالية لهجين من القطن المصرى، كانت تقديرات معامل الاختلاف الوراثى والمظهرى عالية لصفة محصول الشعر ووصلت الى ٣٩,٨٨و ٣٩,٩١%، ٣٠,٨٥و ٣٠,٨٨% بعد دورتين من الانتخاب فى الجيل الثانى ودورة واحدة من الانتخاب فى الجيل الثالث، عموما كانت تقديرات معامل الاختلاف فى الانتخاب فى الجيل الثالث اقل من تقديرات الانتخاب فى الجيل الثانى فى معظم الصفات المدروسة، كما اظهرت النتائج ان تقديرات كفاءة التوريث كانت عالية لكل الصفات المدروسة فى طريقتى الانتخاب. متوسط أداء العائلات المنتخبة بعد دورتين من الانتخاب فى الـــF_2 لصفة محصول الشعر للنبات تراوحت بين ٤١،٩٠ جم للعائلة المنتخبة رقم ١٧٦و ٨١،٩٠ جم للعائلة المنتخبة رقم ١٦٢ بمتوسط قدرة ٥٨،١٣ جم لكل العائلات المنتخبة، بينما تراوح متوسط العائلات بعد دورة واحدة من الانتخاب فى الـــF_3 لنفس الصفة من ٥٧،٧٠جم للعائلة المنتخبة رقم ١٩٥ الى ٨١،٩٠جم للعائلة المنتخبة رقم ١٦٢ بمتوسط قدرة ٦٧،٥١جم لكل العائلات المنتخبة. كما اظهرت النتائج استجابة عالية للانتخاب فى الـــF_2 لمحصول الشعر مقارنة بافضل الابوين وصلت الى ١٣،١٥%، اظهرت ستة عائلات منتخبة استجابة معنوية مقارنة بافضل الابوين تراوحت بين ١٠،٢٥ % للعائلة رقم ١٩٠ الى ٥٩،٤٣% للعائلة رقم ١٦٢. كما اظهرت النتائج استجابة عالية للانتخاب فى الجيل الثانى لمحصول الشعر مقارنة بمتوسط الابوين وصلت الى ٣٣،٧٢%، اظهرت ثمانية عائلات منتخبة استجابة معنوية مقارنة بمتوسط الابوين. واظهرت النتائج استجابة عالية المعنوية للانتخاب فى الجيل الثالث F_3 لمحصول الشعر مقارنة بافضل الابوين وصلت الى ٣١،٤٢% مقارنة بمتوسط

استجابة وصل الى ١٣،١٥% للانتخاب فى الـــF_2، كل العائلات العشرة المنتخبة لصفة المحصول اظهرت استجابة معنوية للانتخاب فى الـــF_3 تراوحت بين ١٢،٣٢% للعائلة رقم ١٩٥ الى ٥٩،٤٣% للعائلة رقم ١٦٢، وايضا كانت هناك استجابة عالية المعنوية للانتخاب فى الـــF_3 مقارنة بمتوسط الابوين تراوحت بين ٣٢،٧٤% و ٨٨،٤١% للعائلتين ١٩٥ و ١٦٢، على التوالى. اظهرت نتائج الارتباط المظهرى بعد دورتين من الانتخاب فى الـــF_2 ان هناك ارتباط موجب وعالى المعنوية بين صفة محصول الشعر وكلا من محصول القطن الزهر (٠،٩٩)، وزن اللوزة (٠،٥١)، عدد اللوز على النبات (٠،٩٦)، معامل الشعر (٠،٦١)، وكان الارتباط متوسط مع كلا من تصافى الحليج (٠،٣٩) و معامل البذرة (٠،٤٩) وارتباط منخفض مع كلا من قراءة الميكرونير (٠،٠٧) و طول الشعر (٠،٠٣)، بينما كان هناك ارتباط سالب وعالى المعنوية مع معامل الانتظام (-٠،٥٤). ايضا، بعد دورة واحدة من الانتخاب الثالث وجد ان قيم معامل الارتباط كانت موجبة وعالية بين محصول الشعر للنبات وكلا من محصول القطن الزهر للنبات (٠،٩٦)، وزن اللوزة (٠،٦٠) و عدد اللوز على النبات (٠،٧٨). يتضح من نتائج معامل الارتباط ان هذه الصفات هى المساهم الأساسى فى صفة محصول الشعر للنبات وان الانتخاب لاى من هذه الصفات يؤدى الى زيادة محصول الشعر للنبات. كذلك يتضح من تلك النتائج ان الانتخاب فى الجيل الانعزالى الثانى افضل فى تحسين متوسط العائلات المنتخبة من الانتخاب فى الجيل الانعزالى الاول.