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Efficiency of selection index in improvement yield and yield components in segregating population of Egyptian cotton

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Abstract

The present study was carried out at Shandaweel Research Station, Cotton Research Institute, Agriculture Research Center, Sohag, Egypt during the three summer seasons of 2014-2016. The basic materials consisted of F2- population stemmed from the cross between (Giza 90 X Giza 80). The population was subjected to pedigree selection for two cycles. The selection procedures were single trait selection for lint yield/plant, in addition to eight selection indices. The index selection proposed by Pesek and Baker (1970) was used with different combinations of characters. The main objective of this study was to determine efficiency of selection index procedure in isolate elite high yielding genotypes. Average observed genetic gain of the ten selected families after tow cycles of selection indicated that lint yield/ plant ranged from 9.08% ($P \leqslant 0.01$) for index 7 to 22.73% ($P \leqslant 0.01$) for index 2. Index 5 and index 8 ranked the first and showed significant genetic gain of (12.30 and 15.00%), (17.88 and 15.43%), (13.60and 13.97%), (5.38 and 7.20%) and (17.76 and 10.36%) for seed cotton yield, lint yield, boll weight, seed index and lint index; respectively. Index 2 ranked the second who gave significant genetic gain of 20.75, 22.73, 15.81, 7.53 and 15.43% for the same previous traits respectively. While, the single trait selection for lint yield/plant ranked the last and showed significant genetic gain of 11.08, 9.69, 16.18, 7.96 and 10.78% for seed cotton yield, lint yield, boll weight, seed index and lint index; respectively. These results indicated that selection index was better than single trait selection in isolated superior families in yield and yield components.

Keywords: cotton, selection index, efficiency, genotypes.

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1. Introduction

Cotton is one of the most important fiber crops in the world. It has soft staple fibers that grow on the seeds of cotton plant, a shrub native to tropical and subtropical regions around the world, including the Americas, India, and Africa. However, virtually all of the commercial cotton grown worldwide today is grown from the two species *Gossypium hirsutum* and *Gossypium barbadense*. The fiber most often is spun into yarn or thread and used to make a soft breathable textile, which is the most widely, used natural-fiber cloth in clothing today. Plant breeders are continuously searching for more effective and efficient selection method. Although, several selection methods were used for improving several traits in cotton, pedigree selection method has become the most common plant breeding procedure. Most of Egyptian cotton varieties were produced by this method. Selection index techniques can be used to improve several traits simultaneously (Manning, 1956; Smith 1936; Pesek and Baker, 1969; 1970); however, it has been criticized for the labor and time needed for computations. On the other hand, computers provide a good opportunity to use such techniques in plant breeding programs. Selection depends mainly upon genetic variability (Abo El-Zahab and El-Kelany, 1979; Mahdy, 1983; Manning, 1956). Likewise, Soomro *et al.* (2010) recorded high heritability for plant height, bolls/plant and seed cotton yield/plant ranged from 72.97 to 75.55%. Whereas, El-Lawendy and El-Dahan (2012) found that, heritability obtained in both F3 and F4-generations ranged from moderate to high (51.3 to 96.3%) for all traits. After two cycles of selection for lint percentage in tow segregating populations, Hassaballa *et al.* (2012) estimated broad sense heritability of 64 to 73% for tow populations. Many researchers indicated that selection index techniques were mostly better than single trait selection (Abo El-Zahab and El-Kelany, 1979; El-Lawendy and El-Dahan, 2012; El-Okkia *et al.*, 2008; Gomaa *et al.*, 1999; Kamalanathan, 1967; Kassem *et al.*, 2008; Mahdy, 1983; Mahdy *et al.*, 2017; Singh *et al.*, 1995; Tang *et al.*, 2009; Walker, 1960). The present work aimed to determine efficiency of selection index procedure in improvement yield and isolate superior promising genotypes from Egyptian cotton hybrids or populations.

2. Materials and methods

The present study was carried out at Shandaweel Research Station, Cotton Research Institute, Agriculture Research Centre, Sohag, Egypt during the three summer seasons of 2014-2016. The basic materials consisted of 200 single plants from F2- population stemmed from the cross between (Giza 90 X Giza 80). The population was subjected to pedigree selection for two cycles. The selection procedures were single trait selection for lint yield/plant, in addition to eight selection indices. The index selection proposed by Pesek and Baker (1970) was used with different combinations of traits. In Season 2009, two hundred single plants along with the two parents sown on March, 26th. A Randomized Complete Block Design of three replications was used in three seasons. In the three seasons; the plot size was one row, 4 m long, 60 cm apart and 40 cm between hills within a row. After full emergence, seedlings were thinned at one plant per hill (11 plants/ row). The recommended cultural practices were adopted throughout the growing season. At the end of the growing season two pickings were done. The recorded traits in the three seasons were; seed-cotton yield/ plant, gram, lint yield/ plant, gram, lint percentage, number of bolls/ plant, boll weight, gram, seed index, lint index, estimated as (weight of lint cotton in a sample/weight of seeds in this sample) x seed index and earliness index, measured as weight of the first pick / weight of the two picks.

2.1 Single trait selection

The F2-generation, season 2014, the 20 superior families in lint yield/plant were assigned. The best plant from each family was saved for the next season.

2.2 Multiple traits selection (selection indices)

Means of 200 single plants were ranked using 8 models of selection indices for the modified "desired genetic gain" method (Pesek and Baker, 1969; 1970). The best plant from each of the superior 20 families was selected and saved for next season. In season 2015, the sowing date was March 28th, 2015. The selected plants were grown using the same experimental design and the same plot size of the previous season. The second cycle of pedigree selection for lint yield/ plant and the eight selection indices was applied as in the first season. The best plant from each 10 superior families from the 20 families of single trait selection or selection index were selected and saved for the next season. In season 2016, sowing date was March 28th, 2016, experimental design and the plot size was as the previous season. One experiment was raised to evaluate the two cycles of single trait selection and the eight selection index models. The experiment included the ten superior selected families for single trait selection and each model of the 8selection index.

2.3 Statistical analysis

Estimation of phenotypic covariance between pairs of traits of single plants in season 2014 depended on the mathematical fact: IF C=A+B Then $\sigma^2_C = \sigma^2_A + \sigma^2_B + 2cov_{AB}$. Estimates of genotypic and phenotypic variances and covariance's in the second and third seasons were calculated from EMS and EMCP components of the selected families as outlined by Walker (1960). Calculation of selection indices was done as Pesek and Baker (1969 and 1970). The desired genetic gain was assigned as 10% increase from the population mean of each trait in the index. The phenotypic value of a family (I) was estimated using the following formula as outlined by Smith (1936) and Hazel (1943). The phenotypic and genotypic coefficients of variation were estimated using the formula developed by Burton (1952). Mean comparisons were calculated by using revised L.S.D. according to El Rawi and Kalafalla (1980). The significancy of observed direct and correlated response to selection was measured as deviation percentage of family mean from the better parent using L.S.D. Evaluation of the selection procedures: To compare the different selection procedures, each family was weighted. The values of the observed gain from the better parent for all studied traits was added together to give a value for each family (v). The highest value (v) takes a weight (w). The "w" was given descending order; from "N" for the highest value "v" to one for the lowest "v". Afterwards, the selection procedures were evaluated as: Score = Score = w x v x n/N. Where: n= number of superior family detected by a selection procedure, and N= is the total of the superior families detected by all procedures at the condition of equal selection intensity.

3. Results and Discussion

3.1 Description of the base population

The family means (Table 1) showed wide range in all studied traits; seed cotton yield/plant ranged from 19.56 to 162.97 g. with an average of 76.53g, lint yield/plant ranged from 5.04 to 66.52 g with mean of 27.57g., number of bolls/plant ranged from 7.42 to 57.92 boll with an average of 26.69 boll and earliness index ranged from 0.14 to 1.00 with an average of 0.52. These wide range in means of previous traits accompanied with high coefficients of variation of 43.66, 47.90, 35.55 and 40.42% for seed cotton, lint yields/plant, number of bolls/plant and earliness index, respectively. These results indicated to feasibility of selection for these traits. The coefficients of variability were medium for the other traits and record of 12.14, 16.53, 9.61 and 25.58% for lint percentage, boll weight, seed and lint indices, respectively. The results of phenotypic coefficient of variability in the base population are in agreement with those reported by Mahdy *et al.*(2009a,b and 2017) and Hassaballa *et al.* (2012) respect to seed cotton, lint yields and number of bolls.

Table (1): Description of the base population in the F2-generation.

	Studied traits							
	Seed cotton yield/plant (g)	Lint yield /plant (g)	Lint percentage	Boll weight (g)	No. of bolls/plant	Seed index (g)	Lint index (g)	Earliness index
Means	76.53±2.36	27.57±0.93	35.41±0.30	2.80±0.03	26.69±0.67	9.49±0.06	5.34±0.10	0.52±0.01
CV	43.66	47.90	12.14	16.53	35.55	9.61	25.58	40.42
MIN	19.56	5.04	21.54	1.63	7.42	7.18	2.34	0.14
MAX	162.97	66.52	41.72	3.50	57.92	11.75	8.00	1.00
G.90	80.23	31.23	38.93	2.63	30.51	9.42	6.00	0.87
G.80	65.95	23.45	35.56	2.85	23.14	8.99	4.96	0.85

3.2 Evaluation of the second cycle of selection season 2016

3.2.1 Variability and heritability estimates

3.2.1.1 Single trait selection (Lint yield/plant)

The analysis of variance, phenotypic (pcv) and genotypic (gcv) coefficients of variation, and heritability estimates after two cycles of selection for lint yield/plant are presented in Table 2. The families mean squares of the selection criterion; lint yield/plant and the other studied traits were significant (P<0.01). The gcv and pcv% were high and accounted for 22.59 and 22.91%, indicating sufficient genetic variability for further cycles of selection for lint yield/plant. The pcv and gcv % were high for seed cotton yield/plant, number of bolls/plant and lint index; and intermediate for lint percentage, boll weight, seed index and earliness index. High broad-sense heritability estimates for all traits in a study of selection for yield and yield components after tow cycles of selection. Mahdy (1983) reported sufficient genetic variability in lint yield/ plant, number of bolls/ plant and lint/ seed after two cycles of pedigree selection for lint yield/plant. Younis (1986) found that the pcv and gcv decreased rapidly after two cycles of pedigree selection. Singh *et al.* (1995) found significant genotypic differences for all traits in the F3 and F4-generations in three crosses. Okasha (1998) noted high to moderate broad-sense heritability estimates for all traits in a study of direct selection for yield and yield components. Shaheen *et al.* (2000), Mahdy *et al.* (2001) and Hassaballa *et al.* (2012) are in line with the results herein respect to heritability estimates and coefficient of variability.

3. 2.1.2 Multiple trait selection (selection index)

The analysis of variance, phenotypic and genotypic coefficients of variation, and heritability estimates after two cycles of selection index are presented in Table (2). The range of genotypic coefficient of variability was high for seed cotton yield/plant (14.39-22.26%), for lint yield/plant (19.34-23.29%), number of bolls/plant (13.43-24.19%), lint index (10.71-14.64%) and earliness index (7.44-12.23), while it was moderate for the other traits. Broad sense heritability estimates were high for all studied traits in all selection indices procedures. Srour *et al.* (2010) Fond decrease in PCV and GCV% from F2 to F3, however heritability increased. Mahdy *et al.* (2009a,b and 2017) found decrease in variability in lint yield/plant, earliness index, seed cotton yield/plant, boll weight and number of boll/plant after tow cycles of selection in segregating populations.

3.2.2 Means and observed gain

3.2.2.1 Single trait selection (Lint yield/plant)

Means and observed gain of the selected families for lint yield/plant are presented in Tables 3 and 4. Mean lint yield/ plant for the ten selected families was 15.48 g. The average direct observed gain from the better parent indicated that tow selected families which showed significant (P<0.01) direct gain in lint yield/plant ranged from 19.39 for family No. 156 to 41.57 for family No.144 with an average of 9.69%. Younis (1986) indicated that pedigree selection for lint yield/plant was the most efficient procedure for improving lint yield/plant. Mahdy *et al.*

(1987) reported direct observed gain in lint yield/plant exceeded the mid-parent by 32.88%. El-Okkiah et al. (2008), Mahdy *et al.* (2009 a,b) and Hassaballa *et al.* (2012) are in agreement with these results.

3. 2.2.2 Multiple trait selection (selection index)

Means and observed gain of the studied traits of the selected families of selection indices procedures are shown in Tables (3) and (4). Selection index 1 resulted in three superior early high yielding families No.122, No.144 and No.181. The best one; No.144 showed significant ($p<0.01$) observed gain from the better parent for yields. Selection index 2 ranked the first in improving lint yield/plant between the studied indices. Four superior families; No. 15, 62, 122 and No.144 showed significant observed gain from the the better parent for yields, earliness index and some traits. The best superior family No. 62 showed significant ($p<0.01$) observed gain from the better parent of 41.61, 52.01, 7.21, 14.71, 17.29, 19.25, 37.21 and 6.02% for seed cotton yield/plant, lint yield/plant, lint percentage, boll weight, number of bolls/plant, seed index, lint index and earliness index; respectively. Selection index 3 resulted in three superior promising families; No.62, No.122 and No.181 in both yields and earliness index from the better parent. The best one; family No. 62 showed significant ($p<0.01$) observed gain from the better parent for all traits, which accounted for 41.61% for seed cotton yield/plant, 52.01% for lint yield/plant, 7.21% for lint percentage, 14.71% for boll weight, 17.29% for number of bolls/plant, 19.25% for seed index, 37.21% for lint index and 6.02% for earliness index. Selection index 4 detected three superior promising families; No.62, 122 and No.156 both in yields and earliness index. The best family No.62 showed significant observed gain from the better parent of 41.61, 52.01, 14.71, 17.29, 37.21 and 6.02% for seed cotton yield/plant, lint yield/plant, boll weight, number of bolls/plant, lint index and earliness index, respectively. Selection index 5, the observed gain indicated to five superior families; No.15, No.62, No.122, No.144 and No.181. The best superior and promising family No.62 showed significant ($p<0.01$) observed gain of 41.61, 52.01, 7.21, 14.71, 37.21 and 6.02% from the better parent for all traits except, followed by family No.144 which showed significant observed gain ($p<0.01$) from the better parent of 23.12, 41.57, 14.90, 22.43, 34.67 and 10.84% for seed cotton yield/plant, lint yield/plant, lint percentage, boll weight, lint index and earliness index, respectively. Selection index 6 detected four superior families; No. 62, 75, 122 and No.156. The four families showed significant ($p<0.01$) observed gain in yields from the better parent. Selection index 7 detected four superior families; No. 62, 75, 122 and No.181. These four families showed significant ($p<0.05$-<0.01) observed gain from the better parent in yields and earliness index. Both of selection index 7 (ranked the second) and index 8 (ranked the eighth) shared in three out of the four superior families; No.62, 75 and No.122.

Table (2): mean squares, genotypic (gcv), phenotypic (pcv) coefficients of variability and broad sense heritability estimates (H) of the selected families for all the studied traits of all selection procedures; season 2016.

S.O.V	D.F	Seed cotton yield /plant (g)	Lint yield /plant (g)	Lint percentage	Boll weight (g)	No. of bolls /plant	Seed index (g)	Lint index (g)	Earliness index
Single trait selection for Lint yield/P;g									
Reps	2	27.521	6.826	2.811	0.016	7.338	0.185	0.093	0.0002
Families	11	285.189**	38.300**	29.327**	0.289**	35.878**	1.302**	1.135**	0.013**
Error	22	2.349	0.360	0.622	0.068	3.955	0.151	0.089	0.0001
gcv		22.68	22.91	8.74	13.65	23.97	8.01	12.57	7.75
pcv		22.40	22.59	8.47	9.84	20.46	6.78	11.22	7.67
Hb		97.57	97.23	93.90	52.00	72.90	71.76	79.66	97.73
Index 1 involved seed cotton, lint yields and boll weight									
Reps	2	4.17	0.002	2.44	0.014	1.19	0.008	0.24	0.001
Families	11	173.18**	32.47**	33.77**	0.31**	18.84**	1.095**	1.002**	0.027**
Error	22	2.8	0.26	1.03	0.029	0.83	0.093	0.049	0.0004
gcv		15.94	19.80	9.47	9.54	16.50	5.89	10.71	12.23
pcv		16.33	20.03	9.90	10.92	17.60	6.66	11.50	12.51
Hb		98.38	99.20	96.95	90.65	95.59	91.51	95.11	98.52
Index 2 involved seed cotton, lint yields and number of bolls									
Reps	2	0.886	0.45	0.82	0.019	0.796	0.0001	0.096	0.0005
Families	11	392.28**	42.15**	34.87**	0.34**	50.04**	1.37**	2.001**	0.021**
Error	22	4.21	0.49	1.13	0.027	1.6	0.122	0.084	0.0006
gcv		22.11	20.73	9.53	10.26	24.19	6.45	14.64	10.23
pcv		22.46	21.09	10.00	11.52	25.36	7.33	15.57	10.67
Hb		98.93	98.84	96.76	92.06	96.80	91.09	95.80	97.14
Index 3 involved lint yield, boll weight and lint index									
Reps	2	3.52	0.003	2.28	0.015	1.33	0.008	0.232	0.0005
Families	11	211.64**	36.55**	29.49**	0.29**	23.00**	1.55**	1.53**	0.023**
Error	22	2.66	0.433	1.16	0.036	1.38	0.083	0.056	0.0006
gcv		17.33	20.71	8.87	9.13	17.59	6.94	13.07	11.36
pcv		17.66	21.08	9.40	10.90	19.20	7.50	13.79	11.81
Hb		98.74	98.82	96.07	87.59	94.00	94.65	96.34	97.39
Index 4 involved lint yield, number of bolls, seed and lint indices									
Reps	2	0.599	0.003	0.44	0.067	2.45	0.017	0.095	0.0005
Families	11	143.24**	32.89**	28.94**	0.316**	14.97**	1.52**	1.35**	0.013**
Error	22	2.95	0.37	1.14	0.034	1.78	0.092	0.068	0.0006
gcv		14.39	19.45	8.60	9.97	13.43	7.03	12.13	7.97
pcv		14.83	19.78	9.11	11.64	15.92	7.68	13.06	8.52
Hb		97.94	98.88	96.06	89.24	88.11	93.95	94.96	95.38
Index 5 involved seed cotton yield and lint index									
Reps	2	2.78	0.61	0.59	0.033	1.07	0.047	0.058	0.0002
Families	11	237.69**	33.97**	35.99**	0.34**	40.74**	2.34**	1.75**	0.022**
Error	22	4.02	0.51	1.09	0.032	1.57	0.089	0.073	0.0005
gcv		18.45	19.34	9.42	10.37	22.92	8.84	13.43	10.42
pcv		18.92	19.78	9.85	11.87	24.26	9.35	14.28	10.78
Hb		98.31	98.50	96.97	90.59	96.15	96.20	95.83	97.73
Index 6 involved seed cotton yield, seed and lint indices									
Reps	2	2.56	0.025	0.62	0.036	2.19	0.11	0.17	0.0002
Families	11	289.81**	38.80**	34.93**	0.39**	23.66**	1.56**	1.50**	0.012**
Error	22	3.01	0.36	1.18	0.03	1.64	0.092	0.074	0.0004
gcv		19.01	20.34	9.81	10.97	16.48	6.93	13.10	7.64
pcv		19.31	20.62	10.31	12.27	18.22	7.56	14.08	8.03
Hb		98.96	99.07	96.62	92.31	93.07	94.10	95.07	96.67
Index 7 involved lint yield, boll weight, number of bolls and earliness index									
Reps	2	0.087	0.007	0.064	0.023	0.91	0.069	0.061	0.0002
Families	11	339.90**	41.95**	31.44**	0.34**	32.35**	1.47**	1.33**	0.011**
Error	22	2.98	0.37	1.21	0.033	1.89	0.13	0.071	0.0004
gcv		22.26	23.29	9.46	10.47	20.24	6.69	12.79	7.44
pcv		22.55	23.60	10.01	12.04	22.04	7.60	13.83	7.85
Hb		99.12	99.12	96.15	90.29	94.16	91.16	94.66	96.36
Index 8 involved lint yield, seed, lint and earliness indices									
Reps	2	0.77	0.024	0.03	0.024	0.87	0.071	0.029	0.001
Families	11	211.97**	41.35**	36.74**	0.40**	39.51**	1.42**	1.59**	0.023**
Error	22	4.04	0.43	1.19	0.035	1.97	0.10	0.068	0.0004
gcv		16.99	21.85	10.04	11.25	21.88	6.65	13.64	10.89
pcv		17.48	22.19	10.54	12.77	23.54	7.37	14.53	11.17
Hb		98.09	98.96	96.76	91.25	95.01	92.96	95.72	98.26

Table (3): Means of the ten selected families for all selection procedures after two cycles of selection, season 2016.

Criterion of selection	Seed cotton yield/plant (g)	Lint yield /plant (g)	Lint percentage	Boll weight (g)	No. of bolls /plant	Seed index (g)	Lint index (g)	Earliness index
Lint	42.79	15.48	36.23	2.77	15.87	9.35	5.33	0.86
Index 1	47.28	16.55	34.90	3.21	14.85	9.81	5.26	0.77
Index2	51.45	17.98	35.19	3.15	16.61	10.00	5.46	0.81
Index 3	48.16	16.75	34.65	3.19	15.26	10.08	5.36	0.76
Index 4	47.53	16.93	35.41	3.07	15.61	9.81	5.39	0.81
Index 5	47.85	17.27	36.22	3.09	15.77	9.80	5.57	0.81
Index 6	51.44	17.60	34.20	3.16	16.44	10.09	5.26	0.81
Index 7	47.61	15.98	33.56	3.05	15.74	9.99	5.06	0.80
Index 8	49.00	16.91	34.27	3.10	16.17	9.97	5.22	0.80
Giza 80	37.69	12.01	31.89	2.72	13.86	9.30	4.36	0.83
Giza 90	42.61	14.65	34.42	2.58	16.60	9.01	4.73	0.76

Selection index 9 detected five superior families; No.15, 62, 122, 144 and No.181, which showed significant observed gain from the better parent in yields and earliness index and some traits. The best selected family No.62 showed significant ($p<0.01$) observed gain from the better parent for eight traits which were 41.61, 52.01, 7.21, 14.71, 17.29, 19.25, 37.21 and 6.02% for seed cotton yield/plant, lint yield/plant, lint percentage, boll weight, number of bolls/plant, seed index and earliness index, respectively. The second promising family No.144 showed significant ($p<0.01$) observed gains from the better parent accounted for 23.12, 41.57, 14.90, 22.43, 34.67 and 10.84% for seed cotton yield/plant, lint yield/plant, lint percentage, boll weight, lint index and earliness index; respectively. However, Manning (1963) who recorded, about 30% increase in lint yield in twelve generation of selection index for improving lint yield of Upland cotton. Kamalanathan (1967) who found that the number of bolls/plant, number of seeds/boll and lint index had the most influence on lint yield/plant. Miller and Rawlings (1967) who found that, selection for seed cotton yield was found to change correlations between earliness and yield. Moreover, they reported that whenever selection increased lint yield, the fiber strength decreased.

3.3 The relative merits of the selection procedures

The observed gain in percentage from the better parent for the studied traits of the superior families selected by different selection procedures are presented in Table (5). All the selection procedures resulted in seven superior promising families. Pedigree selection for lint yield/plant was inferior to detect the superior families in the population. The eight selection indices were better than single trait selection for lint yield/plant. Generally, the selection index involving yield and its attributes could be recommended. Selection indices 5 and 8 ranked the first, scored 2161.95 and detected five out of the seven superior families; No.15, 62, 122, 144 and No.181. Selection index 2 ranked the second, scored 1657.01 and detected four superior families; No.15, 62, 122 and No.144.

Table (4): Observed direct and correlated responses after two cycles of selection index of the promising selected families measured in percentage of the better parent; season 2016.

Families	Seed cotton yield /plant (g)	Lint yield /plant (g)	Lint percentage	Boll weight (g)	No. of bolls /plant	Seed index (g)	Lint index (g)	Earliness index
				Lint yield/P;g				
144	23.12**	41.57**	14.90**	22.43**	-5.12	4.73	34.67**	10.84**
156	10.65**	19.39**	7.84**	8.46	-3.80	0.65	16.70**	2.41**
Average	11.08**	9.69**	-0.41	16.18*	-8.80	7.96**	10.78*	-1.20
				Index 1,				
122	16.31**	24.57**	7.00**	5.51	4.16	3.44	18.60**	0.00
144	23.12**	41.57**	14.90**	22.43**	-5.12	4.73	34.67**	10.84**
181	8.99**	22.12**	11.91**	10.66*	-6.39	-4.19	17.97**	2.41
Average	10.96**	12.97**	1.39	18.01**	-10.54	5.48*	11.21**	-7.23
				Index 2				
15	46.77**	37.68**	-6.28	-8.82	52.29**	7.10*	0.21	4.82*
62	41.61**	52.01**	7.21**	14.71**	17.29**	19.25**	37.21**	6.02**
122	16.31**	24.57**	7.00**	5.51	4.16	3.44	18.60**	0.00
144	23.12**	41.57**	14.90**	22.43**	-5.12	4.73	34.67**	10.84**
Average	20.75**	22.73**	2.24	15.81**	0.06	7.53*	15.43**	-2.41
				Index 3				
62	41.61**	52.01**	7.21**	14.71**	17.29**	19.25**	37.21**	6.02**
122	16.31**	24.57**	7.00**	5.51	4.16	3.44	18.60**	0.00
181	8.99**	22.12**	11.91**	10.66*	-6.39	-4.19	17.97**	2.41
Average	13.03**	14.33**	0.67	17.28**	-8.07	8.39**	13.32**	-8.43
				Index 4				
62	41.61**	52.01**	7.21**	14.71**	17.29**	19.25**	37.21**	6.02**
122	16.31**	24.57**	7.00**	5.51	4.16	3.44	18.60**	0.00
156	10.65**	19.39**	7.84**	8.46	-3.80	0.65	16.70**	2.41
Average	11.55**	15.56**	2.88	12.87*	-5.96	5.48*	13.95**	-2.41
				Index 5				
15	46.77**	37.68**	-6.28	-8.82	52.29**	7.10*	0.21	4.82*
62	41.61**	52.01**	7.21**	14.71**	17.29**	19.25**	37.21**	6.02**
122	16.31**	24.57**	7.00**	5.51	4.16	3.44	18.60**	0.00
144	23.12**	41.57**	14.90**	22.43**	-5.12	4.73	34.67**	10.84**
181	8.99**	22.12**	11.91**	10.66*	-6.39	-4.19	17.97**	2.41
Average	12.30**	17.88**	5.23*	13.60*	-5.00	5.38*	17.76**	-2.41
				Index 6				
62	41.61**	52.01**	7.21**	14.71**	17.29**	19.25**	37.21**	6.02**
75	73.72**	54.47**	-11.13	21.69**	35.06**	5.05	-8.88	-1.20
122	16.31**	24.57**	7.00**	5.51	4.16	3.44	18.60**	0.00
156	10.65**	19.39**	7.84**	8.46	-3.80	0.65	16.70**	2.41
Average	20.72**	20.14**	-0.64	16.18**	-0.96	8.49**	11.21*	-2.41
				Index 7				
62	41.61**	52.01**	7.21**	14.71**	17.29**	19.25**	37.21**	6.02**
75	73.72**	54.47**	-11.13	21.69**	35.06**	5.05	-8.88	-1.20
122	16.31**	24.57**	7.00**	5.51	4.16	3.44	18.60**	0.00
181	8.99**	22.12**	11.91**	10.66*	-6.39	-4.19	17.97**	2.41
Average	11.73**	9.08**	-2.50	12.13*	-5.18	7.42*	6.98	-3.61
				Index 8				
15	46.77**	37.68**	-6.28	-8.82	52.29**	7.10*	0.21	4.82*
62	41.61**	52.01**	7.21**	14.71**	17.29**	19.25**	37.21**	6.02**
122	16.31**	24.57**	7.00**	5.51	4.16	3.44	18.60**	0.00
144	23.12**	41.57**	14.90**	22.43**	-5.12	4.73	34.67**	10.84**
181	8.99**	22.12**	11.91**	10.66*	-6.39	-4.19	17.97**	2.41
Average	15.00**	15.43**	-0.44	13.97*	-2.59	7.20**	10.36*	-3.61

Selection index 7 ranked the third, scored 1568.9 and detected four superior families; No.62, 75, 122 and No.181. Selection index 6 ranked the fourth, scored 1531.96 and detected four selected families; No.62, 75, 122 and No.156. Selection index 4 ranked the fifth, scored 714.96 and detected three families; No.62, 122 and No.156. Selection index 3 ranked the sixth and selection index 1 ranked the seventh and detected three families; No.122, 144 and No.181. Single traits selection for lint yield/plant ranked the eighth (the inferior procedure) and detected only two families; No.144 and No.156. Selection index method was better and more efficient in isolating early high yielding families than single trait selection (Mahdy, 2017). The selection index involved seeds/boll and lint/seed exhibited the highest predicted genetic advance from F3 to F4 for lint yield (El-Okkiah *et al.*, 2008). From F4 to F5 the predicted genetic advance of lint yield exhibited maximum values using the index Ixw.

Table (5): The observed gain in percentage from the better parent for the studied traits of the superior selected families by different selection procedures.

Items	Fam. No.15	Fam. No.62	Fam. No.75	Fam. No.122	Fam. No.144	Fam. No.156	Fam. No.181	Score
Seed cotton yield/p;g	46.77**	41.61**	73.72**	16.31**	23.12**	10.65**	8.99**	
Lint yield/p;g	37.68**	52.01**	54.47**	24.57**	41.57**	19.39**	22.12**	
Lint percentage	-6.28	7.21**	-11.13	7.00**	14.90**	7.84**	11.91**	
Boll weight;g	-8.82	14.71**	21.69**	5.51	22.43**	8.46	10.66**	
Number of bolls/p	52.29**	17.29**	35.06**	4.16	-0.512	-3.80	-6.39	
Seed index;g	7.10*	19.25**	5.05	3.44	4.73	0.65	-4.19	
Lint index	0.21	37.21**	-8.88	18.60**	34.67**	16.70**	17.97**	
Earliness index	4.82*	6.02**	-1.20	0.00	10.84**	2.41	2.41	
Value(V)	133.77	195.31	168.78	79.59	151.75	62.31	63.48	
Weight (W)	4	7	6	3	5	1	2	
Selection for								
Lint yield/p;g					+	+		234.59
Index1				+	+		+	481.92
Index 2	+	+		+	+			1657.01
Index 3		+		+			+	495.11
Index 4		+		+		+		714.96
Index 5	+	+		+	+		+	2161.95
Index 6		+	+	+		+		1531.96
Index 7		+	+	+			+	1568.9
Index 8	+	+		+	+		+	2161.95

* and ** significant at 0.05 and 0.01 levels of probability; respectively. + the superior selected family by a selection procedure.

Also, maximum predicted responses to selection for lint percentage and seed index in F4 generation were achieved using the direct phenotypic trait selection for lint/seed and seeds/boll, respectively.

4. Conclusions

It could be concluded that the selection index method was more efficient in isolated the elite superior families in most of studied traits, and we can depends on this method from selection in scientific programmes to obtained elite genotypes were superior in all yield and fiber traits together. On other hand, pedigree selection method was inferior to detect the superior genotypes.

References

Abo El-Zahab, A. A. and El-Kilany, M. A. (1979), "Correlated response to several selection procedures for increased lint yield in segregating generations of Egyptian cotton (*Gossypium barbadense L*)", *Beitrage Trop Landwirtsch Veterinarmed*, Vol. 17, pp. 165–172.

Burton, G. W. (1952), "Quantitative inheritance in grasses 6^{th}", *International Grassland Congress*, Vol. 1, pp. 277–283.

El-Lawendey, M. M. and El-Dahan, M. A. A. (2012), "Comparison between direct and indirect selection and two indices in segregating population of cotton (*Gossypium barbadense L.)*", *Journal of Agricultural Research, Kafr El-Shaikh University*, Vol. 38 No. 1, pp. 37–53.

EL-Okkiah A. F. H., Kassem, M. M., Sary, G. A. and EL-Lawendey, M. M. (2008), "Improving lint yield and its components in early segregating generations of Giza 45 x Giza 75 cotton cross", *Egyptian Journal of Agricultural Research*, Vol. 86, pp. 631–641.

El Rawi, K. and Kalafalla, A. M. (1980), *Design and Analysis of Agricultural Experiments*, El-Mousel University, Iraq, pp. 19.

Gomaa, M. A. M., Shaheen, A. M. A. and Khattab, S. A. M. (1999), "Gene action and selection indices in two cotton (*Gossypium barbadense* L.) Crosses", *Annals of Agricultural Sciences Journal*, Vol. 44, pp. 293–308.

Hassaballa, E. A., Mahdy, E. E., Mohamed, A. A. and Aly, A. M. (2012), "Selection for earliness index in two segregating populations of Egyptian cotton (*G. barbadense* L.) under late planting", *Assiut Journal of Agriculture Science*, Vol. 43 No. 3, pp. 1–17.

Hazel, L. N. (1943), "Genetic basis for selection indices", *Genetics*, Vol. 28, pp. 476–490.

Kamalanathan, S. (1967), "A selection index for lint yield in cotton (*G. arboreum* L.)", *The Madras Agricultural Journa*, Vol. l54, pp. 612–618.

Kassem, M. M., Sary, G. A., EL-Okkiah, A. F. H. and EL-Lawendey, M. M (2008), "Comparison of the efficiencies of the different selection procedures in three populations of Egyptian cottons (*Gossypium barbadense* L.)", *Egyptian Journal of Agricultural Research*, Vol. 86, pp. 623–629.

Mahdy, E. E. (1983), "Selection index in cotton (*G. barbadense* L.)", *Assiut Journal of Agriculture Science*, Vol. 14, pp. 267–282.

Mahdy, E. E., Ismail, A. A., Mahrous, H., Abou-Elwafa, S. F. and Ibrahim,

N. (2017), "Efficiency of single and multiple traits selection for yield and its components in varietal maintenance of Giza 90 Egyptian cotton variety", *Assiut Journal of Agriculture Science*, Vol. 48, pp. 45–58.

Mahdy, E. E., Ismail, A. A., Awad, H. Y. and Mohamed, A. A. (2001), "The relative merits of breeding and modified recurrent selection in improving seed cotton yield in two segregating populations of Egyptian cotton (*G. barbadense* L.)", The 2nd Plant Breed, Conference of Faculty of Agriculture, Assiut University, Egypt, pp. 61–79.

Mahdy, E. E., Hassaballa, E.A., Khalifa, M.A. and Younis, F.G. (1987), "Comparative studies on three selection procedures in an interaspecific population of cotton", *Assiut Journal of Agriculture Science*, Vol. 18, pp. 179–195.

Mahdy, E. E., Hemaida, G. M. K., Abd El-Motagally, F. M. F. and Mostafa, A. (2009a), "Response to selection for yield under late sowing date in two populations of Egyptian cotton", *Assiut Journal of Agriculture Science*, Vol. 40, pp. 1–25.

Mahdy, E. E., Hemaida, G. M. K., Abd El-Motagally, F. M. F. and Mostafa, A. (2009b), "Pedigree selection for lint yield, lint percentage and earliness index in late planting in two populations of Egyptian cotton", *Minia Journal of Agricultural Research and Development*, Vol. 29, pp. 233–258.

Manning, H. L. (1956), "Yield improvement from a selection index technique with cotton", *Heredity*, Vol. 10, pp. 303–322.

Manning, H. L. (1963). “Realized yield component from twelve generations of progeny selection in a variety of Upland cotton”. W.D. Hanson and H.F. Robinson (ed.), *Statistical Genetics And Plant Breeding*, Publication no. 982, National Academy of Sciences - National Research Council, Washington, USA, pp 329–351.

Miller, P. A. and Rawlings, J. O. (1967), "Selection for increased lint yield and correlated response in Upland cotton, (*G. hirsutum* L.)", *Journal of Crop Science and Biotechnology*, Vol. 7, pp. 637–640.

Okasha, A. A. (1998), "Expected and actual gains for yield, yield components and fiber quality in Giza 45 cotton cultivar", *Annals of Agricultural Science Moshtohor Journal*, Vol. 36, pp. 1373–1380.

Pesek, J. and Baker, R. J. (1969), "Desired improvement in relation to selection indices", *Canadian Journal of Plant Science*, Vol. 49, pp. 803–804.

Pesek, J. and Baker, R. J. (1970), "An application of index selection to the improvement of self-pollinated species", *Canadian Journal of Plant Science*, Vol. 50, pp. 267–276.

Shaheen, A. M. A., Gomaa, M. A. M. and Esmail, R. M. (2000), "Response to selection for yield, yield components and fiber properties in three Egyptian cotton crosses", *Annals of Agricultural Sciences Journal*, Vol. 45, No. 2, pp. 491–506.

Singh, B., Chahal, G. S. and Singh, T. H. (1995), "Efficiency of different selection criteria for the improvement of seed cotton yield in early segregating generations of (*Gossypium hirsutum* L.)", *Crop Improvement*, Vol. 22, pp. 61–64.

Smith, H. F. (1936), "A discriminant function for plant selection", *Annual Eugenics*, Vol. 7, pp. 240–250.

Soomro, Z. A., Kumbhar, M. B., Larik, A. S., Imran, M. and Brohi, S. A. (2010), "Heritability and selection response in segreganting generations of Upland cotton", *Pakistan Journal of Agricultural Research*, Vol. 23, pp. 25–30.

Tang, F. Y., Jin, C., Xin, H. W., Cheng, M. W. and Jun, X. W. (2009), "Genetic variation and selection indices of quantitative traits in Upland cotton (*G. hirsutum* L.) lines with high fiber quality", *Journal of Cotton Science*, Vol. 21, pp. 361–365.

Walker, J. T. (1960), "The use of a selection index technique in the analysis of progeny row data", *Empire of Cotton Growing Review*, Vol. 37, pp. 81–107.

Younis, F. G. (1986), *Comparative studies on selection procedure in cotton*, Ph.D. Thesis, Faculty of Agriculture, Assiut University, Assiut, Egypt.