Egypt. J. Agron. **Vol. 44**, No. 2-3, pp. 117-130 (2022)

Egyptian Journal of Agronomy
http://agro.journals.ekb.eg/

Single Trait Selection and Independent Culling Levels in Improving Egyptian Cotton Yield (*G. barbadense* L.) under Normal Irrigation and Water Deficit

E.E. Mahdy[(1)#], S.F. Abou-Elwafa[(1)], G.H. Abdel-Zahir[(2)], N.I. Abdelrahman[(2)]
[(1)]*Department of Agronomy, Faculty of Agriculture, Assiut University, Assiut, Egypt;*
[(2)]*Cotton Research Institute, Agricultural Research Center, Giza, Egypt.*

TRADITIONAL breeding is an important way to develop drought-tolerant varieties. There is a dire need to develop cotton cultivars that can produce acceptable yields in water limited. This work aimed to compare single trait selection and independent culling levels for six traits in improving the seed cotton yield (SCY/p) under water deficit and normal irrigation. The genetic material was the F_2-population of the cross Giza 90 × Giza 95 (long staple). In the F_2, the phenotypic (PCV%) and genotypic (GCV%) coefficients of variability were mostly higher under normal irrigation than under drought stress. The correlations among traits indicated that SCY/p depended mainly upon number of bolls, boll weight and seed index, and moderately on lint index, and the early plants had high yields. The GCV and PCV were greatly depleted by selection and were higher in most cases under drought stress than under normal irrigation. Independent culling levels preserved genetic variability more than single trait selection. Narrow sense heritability was mostly high under normal irrigation. The selections of both methods were evaluated in the F_4 under both environments. Selection for SCY/p under normal irrigation increased SCY/p by 16.9% under normal irrigation and 8.90% under stress, while selection under stress increased SCY/p by 12.05 and 10.69% of the mid-parent under the respective environments. Single trait selection proved that selection under optimum environment performed well under optimum, and selection under drought stress was better under stress. Otherwise, ICL method of selection did well under drought stress.

Keywords: Drought stress, Genotypic coefficient of variation, Narrow sense heritability, Observed gain, Pedigree selection.

Introduction

The various abiotic stress factors affecting cotton growth, development and yield mostly originate due to weather and soil constraints. Water stress is the most crucial factor limiting crop productivity that adversely affects fruit production, square and boll shedding, lint yield, and fiber quality properties in cotton (Rehman et al., 2021). Drought alone affects 45% of the world's agricultural land (Abdelraheem et al., 2019). Its effects on physiology, biochemistry and molecular aspects in cotton have been well documented, it reduces photosynthesis and plant growth, and prolonged field drought causes leaf desiccation, yellowing, wilting, and fruit abscission, leading to reduced fiber yield and quality (Pettigrew, 2004a, b; Kamaran et al., 2016). Drought tolerance improvement is probably one of the challenging tasks of cotton breeders. Drought tolerance is a polygenic trait (Mussell & Staples, 1979; Ahmad et al., 2009) associated with morphophysiological characters moderating the genetic improvement on morphophysiological based selection of crop plants (Singh, 2004). There is a need to develop cotton cultivars that produce acceptable yields in both water shortage and favorable environments (Iqbal et al., 2013). The presence of genetically based difference in drought stress tolerance is a must for developing cultivars tolerant to water stress (Dahab et al., 2012). Although conventional breeding has its limitations, yet it has contributed considerably to developing drought tolerant cotton cultivars. A number of

[#]Corresponding author emails: emahdy@aun.edu.eg, ezzatemahdy@yahoo.com
Received 19/06/2022; Accepted 16/10/2022
DOI: 10.21608/AGRO.2022.145054.1324

breeding lines developed from interspecific hybrids between Upland and Pima cotton at New Mexico State University displayed good drought tolerance (Zhang & Hughs, 2012).

Selection under water deficit is expected to be more efficient, and the genotypes selected for high yield under low yielding conditions were less sensitive to changing environments than selection under favorable conditions (Ceccarelli, 1987; Ceccarelli & Grando, 1991a, b). They indicated that the probability of a crop failure of genotypes selected for high grain yield under high yielding conditions was between 1.8 and 2.7 times higher than for genotypes selected for high yield under low yielding conditions. Selection in different environments was early discussed (Jinks & Connolly, 1973, 1975; Falconer, 1990) they indicated that the antagonistic selection reduces environmental sensitivity and synergistic selection increases it. Falconer (1989) suggested that antagonistic selection might be the best way to improve the mean performance in the two environments.

Fiber quality was significantly affected by drought level and fruiting branch location on the plant (Gao et al., 2020) and water deficit reduced trait means in F_3, F_4 and F_5-generations (AL-Ameer et al., 2015). Under the non-stressed environment pedigree selection was effective in improving seed cotton yield, lint yield, number of bolls/plant and earliness index and identifying superior families (Mahdy et al., 2009 a, b; El-Fesheikawy et al., 2014; Ibrahim et al., 2017). The coefficient of variability of the different traits was decreased by pedigree selection (Mahdy et al., 2009a, b; Abd ElSameea et al., 2020). Several authors indicated that selection index was better than single trait selection in detecting superior families and preserve the genetic variability (Kassem et al., 2008; NaiYin & Jian, 2014; Ibrahim et al., 2017; Soliman, 2018; Mabrouk, 2020). The highest predicted genetic advance from the F_{3-} generation for lint yield/plant was obtained with selection index involved lint yield/plant, bolls/plant, and seeds/boll, pedigree selection for lint/plant, pedigree selection for bolls/plant (El-Dahan, 2016). The efficiency of the selection index consisting of lint yield/plant, bolls/plant, number of fruiting branches, and number of boll position was higher than that of selection for lint yield/plant alone by 12.06% (Tang et al., 2009).

Independent culling levels, also called truncation selection, is a selection strategy whereby a genotype is culled if it does not meet the requirements for certain traits, regardless of its levels on other traits. This strategy guarantees that a genotype that is selected as a new cultivar/variety has no major defects. The Cotton Research Institute in Egypt follow this strategy in the production of new varieties with specific technological characteristics. Once optimal culling levels are achieved, independent culling and index selection lead to comparable genetic gains (Batista et al., 2021). Selection on multiple traits includes independent culling and index selection was recommended (Yan, 2021). This article aimed to compare the single trait selection with independent culling levels in improving yield and its attributes under normal irrigation and water deficit.

Materials and Methods

The experiments were carried out under normal irrigation and soil stressed conditions at Shandaweel Research Station, Sohag Governorate, Agricultural Research Center (A.R.C), Egypt (latitude 26.33N, longitude 31.41E) during 2018 to 2020 growing seasons. Two cycles of single trait selection and independent culling levels were achieved for six traits on a population started in the F_2-generation. The selections under normal irrigation and drought stress were evaluated in the F_4 under both environments.

Soil samples

Soil samples were collected from plots of the experiment at vertical depths of 0-15, 15-30, 30-45 and 45-60 cm before and after irrigation. Soil physical and chemical properties (Tables 1 and 2) were measured according to Israelsen & Hansen (1962), Blake & Hartge (1986), Gee & Bauder, (1986).

Irrigation

In the three seasons, the normal irrigation experiment was surface irrigated as required. However, the stressed experiment was surface irrigated just before the mean of wilting point (mean of wilting point of the four depths) using gravimetric method.

Season 2018, F_2-generation

The genetic material was the F_2- population stemmed from the cross between two long staple Egyptian cotton varieties (*Gossypium barbadense* L.), namely Giza 90 and Giza 95. A total of 500 single plants were planted on March 27th, 2018, under each of water stressed and normal irrigation conditions in non-replicated experiments. One stripe of five meter in width was left in between without planting to prevent water seepage. Seeds were sown in single rows 4m in length, 60cm apart and 40cm between hills within a row. One row was left without planting between each two rows to facilitate selfing and data recording. After full emergence seedlings were thinned to one plant/hill. At flowering self–pollination for ten buds/plant was done, and days to first flower (DFF) was recorded. Before picking, five random open sound bolls were picked from each plant to measure average boll weight (BW, g), seed index (SI, g) and lint index (LI, g). After picking the recorded characters for each single plant were seed cotton yield /plant (SCY g/p), lint yield/plant (LY g/p), lint percentage (Lint %), number of bolls/plant (NB/p) and number of seeds/boll (NS/B). The recommended cultural practices for cotton production were adopted in the three growing seasons.

The selection criteria were SCY/p, LY/p, lint%, NB/p, BW and LI. The ten best selected plants for the six selection criteria and independent culling levels (for the six previous traits) were saved for the second season from each environment. The independent culling levels are presented in Table 3.

Season 2019, F_3 -generation

Selfed seeds of the ten selected plants for each selection criterion and independent culling levels (for the six traits) under normal and stressed conditions along with the two parents were planted in rows (families) as in the previous season on March 25th, 2019, in a randomized complete blocks design of three replications. The best five families were determined and the best plant from each was saved for each selection criterion under normal and stressed conditions.

Season 2020, F_4 -generation

Selfed seeds of the five selected families for the selection criteria and independent culling levels either from normal irrigation or from the drought stressed experiment were evaluated in both environments. Seeds were sown on March 25th, 2020, in a randomized complete blocks design of three replications as in the previous season.

Statistical analysis

The analysis of variance, phenotypic (σ^2p), genotypic variance (σ^2g), significance tests and simple linear correlation among traits were performed as Steel et al. (1997) on plot mean basis. The mathematical model of the randomized complete block design is $Y_{ij} = \mu + \eta i + \xi_j + e_{ij}$

where i= 1,2,3⋯, t and j =1,2,⋯, b with t treatments and b blocks. μ is the overall mean based on all observations, ηi is the effect of the *i*th treatment response, ξ_j is the effect of *j*th block and e_{ij} is the corresponding error term which is assumed to be independent and normally distributed with mean zero and constant variance.

In the random model of the RCBD, the genotypic variance (σ^2g)= (MSg - MSe)/r, Phenotypic variance (σ^2p)= σ^2g+ MSe/r, MSg= genotypes mean square, MSe= error mean square, r= number of replications.

The phenotypic and genotypic coefficients of variation were estimated using the following formula

GCV% = (σg/mean) x 100, PCV% = (σp/mean) x100.

where, σg and σp= genotypic and phenotypic standard deviations, respectively.

Broad sense Heritability (H) and the genetic advance were computed using the formula adopted by Falconer (1989). as follows:

Broad sense Heritability (H%) = (σ^2g / σ^2p) ×100 and the expected genetic gain in the F_2 = k^x σp^x H

where, the environmental variance $\sigma^2_E = (\sigma^2 P_1 + \sigma^2 P_2)/2$, σ^2p= F_2 variance, σ^2g= σ^2p - σ^2_E, k is the selection intensity from selecting 10% superior plants.

Narrow sense Heritability (h^2) was estimated by parent-offspring regression as outlined by Smith & Kinman (1965).

Significance of the observed direct and correlated genetic advance to selection in percentage from the mid- and the better parent was measured using least significant differences (LSD) test to know; if the selection did an actual genetic advance or didn't.

Observed genetic advance from the mid parent= (population mean – mid parent)/ mid parent) *100,

Observed genetic advance from the better parent= (population mean – better parent)/ better parent) *100

TABLE 1. Soil profile and physical analysis of the experimental site at Shandaweel Agricultural Research Station

Depth (cm)	Particle distribution, %				Texture	Hydraulic conductivity (cm/h)	Bulk density (gm/cm^3)	Soil water content, %		
	Course sand	Fine sand	Silt	Clay				Saturation	Field Capacity	Permanent wilting point
A (0-15)	7.80	16.20	38.20	37.80	clay loam	2.90	1.34	56	27.60	15.50
B (15-30)	6.90	15.50	39.50	38.10	clay loam	2.90	1.36	50	28	14.1
C (30-45)	10.00	35.50	45.20	9.30	loam	11.50	1.56	27.1	12.2	7.2
D (45-60)	15.50	33.90	42.10	8.50	loam	10.70	1.57	29.3	15.1	6.4

TABLE 2. Concentration of soil available macro-and micro elements, electrical conductivity (EC), pH, and calcium carbonate in the experimental site

Season	Concentration, mg/100g soil							EC, Ds/m (1:5)	pH	N%	$CaCO_3$%
	HCO^{-3}	Cl^-	$SO4^=$	Ca^{++}	Mg^{++}	Na^+	K^+				
2018	0.30	0.88	1.02	0.52	0.26	1.26	0.16	0.263	7.30	0.20	1.26
2019	0.26	0.79	1.00	0.50	0.24	1.17	0.14	0.246	7.80	0.17	1.41
2020	0.22	0.70	0.98	0.48	0.22	1.08	0.12	0.229	8.30	0.14	1.56

TABLE 3. The independent culling levels (ICL) for the six traits in the F_2 and F_3 generations of Egyptian cotton under normal irrigation (N) and drought tress (D)

	SCY/p, g.	LY/p, g.	L.P%	B.W, g.	N.B/p	L.I, g.
The ICL in the F_2						
N	110.90	42.95	38.42	2.90	33.61	7.02
D	76.00	29.94	37.95	2.5	28.39	5.87
The ICL in the F_3						
N	109.97	41.9	38.12	2.83	35.08	6.47
D	72.67	28.13	38.34	2.47	29.49	5.12

Results and Discussion

Description of the base population; F_2 generation

The characteristics of the parents and the F_2 generation under normal irrigation and drought stressed environments are presented in Table 4. Mean seed cotton yield/plant (SCY/p) of the parents *Giza90* and *Giza95* was 83.38 and 82.31g under normal irrigation, and 56.82 and 62.47 under drought stress with reduction% of 31.85 and 24.11, respectively. Mean SCY/p of the F_2 was 42.83 and 33.13g under normal irrigation and drought stress, respectively, with reduction% of 22.65. The high level of heterozygosity in the F_2 lowered the reduction% than the two parents. The F_2 mean was less than the two parents with under dominance towards the low yielding parent. Phenotypic (PCV%) and genotypic (GCV%) coefficients of variability were high in the F_2 and accounted for 63.91 and 34.80% under normal irrigation, and 51.40 and 14.79% under drought stress; respectively, indicating sufficient variability for selection for SCY/p. Furthermore, the minimum and maximum values for all traits in the F_2-generation located outside the parental values for yield and yield components indicating feasibility of selection. Such wide variability in SCY/p with broad sense heritability of 29.64 and 8.28% resulted in predicted genetic advance in percentage of the mean of 21.78 and 3.40% under normal irrigation and drought stressed environments; respectively. Lint yield/ plant (LY/p) showed the same trend. Likewise, number of bolls/plant (NB/p) showed high PCV%, in consequence high expected genetic advance of 16.18% of the mean under irrigation, but low (4.74%) under drought stress. The expected genetic advance was low for the other traits. The results indicated that except for boll weight (BW) and number of seeds/boll (NS/B) the PCV% was high under normal irrigation than under drought stress. Tang et al. (2009) noted genetic coefficient of variation of seed cotton yield/plant, lint yield/plant and bolls/plant of 16.64, 14.71 and 10.65%, respectively. Lint percentage and boll weight showed the highest broad-sense heritability of 89.1 and 81.85%, respectively. The lowest broad-sense heritability was found for lint yield/plant 55.05%. (Hassaballa et al. (2012a,b) found high estimates of coefficient of variation for lint% and high estimates of heritability of 0.79 and 0.81, and large expected gains of 21.14 and 23.45% for two populations. El-Dahan (2016) reported high predicted genetic advance for lint yield/plant which exceeded 50% of the F_3-generation mean.

Seed cotton yield is a complex trait of several contributing factors, which are in turn highly susceptible to environmental influences. The correlation coefficient analysis measures the magnitude of relationship among yield and its components. It is a helpful tool to assess the component character on which selection can be based for improving yield.

The correlation of SCY/p with the other traits (Table 5) was higher under normal irrigation than under drought stress except for lint% and NS/B. SCY/p depended mainly upon NB/p, BW and SI, and moderately on LI. Negative correlation was found between yield and DFF indicating that the early plants had high yields. The correlation of LY/p showed nearly the same trend, but its correlation with LI was higher than that with SCY/p. Results indicated that the high yielding plants were early. Lint% was more correlated with LY/p than SCY/p and higher under drought stress than under irrigation. Lint index gave high correlation with lint%. Days to first flower showed negative correlation with all traits and was higher under normal irrigation than under drought stress. These results are in line with those reported by Joshi & Patil (2018), Nawaz et al. (2019) and Amein et al. (2020). Likewise, Mahdi & Emam (2020) indicated that earliness index and production rate index had a high and positive correlation with seed cotton yield per plant, while days to the first flower appearance, days to the first boll opening and mean maturity date showed negative correlation with seed cotton yield per plant.

Variances and means

Mean squares in the F_4-generation was significant ($P \leq 0.05$ and $P \leq 0.01$) when selection practiced under normal irrigation either evaluation was done under normal irrigation or under stress, except for two out of 126 cases (Tables 6 and 7). Likewise, selection under drought stress, mean squares was significant for the selection criteria except for few cases (5 out of 126). These results indicate the presence of remained variability in selection criteria after two cycles of selection. These results are in line with those reported by Mahdy et al. (2009b) and Tang et al. (2009).

Coefficients of variation and heritability

Genotypic and phenotypic coefficients of variability were greatly depleted by selection from F_2 to F_4- generation (Tables 8 and 9). Genotypic coefficient of variation under normal irrigation in SCY/p decreased from 34.80% in the F_2 to 4.24% in F_4, and for LY/p decreased from 37.39 to 9.75%. Such decrease was observed for the other selection criteria. However, the differences among the selected families were significant ($P \leq 0.01$) indicating the possibility of further cycle of selection. It is of interest to indicate that the PCV and GCV of the selection criteria in the F_4 were higher in most cases under drought stress than under normal irrigation when selection practiced under both environments. Early, Bucio Alanis & Hill (1966) stated that under poor or adverse environment the differences between genotypes can be detected. These results are in line with those reported by Tang et al. (2009) and Hassaballa et al (2012a, b).

The PCV% and GCV% were slightly higher in magnitude in ICL method than those in single trait selection for SCY/p, Lint%, BW and LI when selection practiced under normal irrigation (Table8). However, selection under drought stress the coefficients of variation were higher for BW and NB/p. Multiple traits selection (ICL) preserved genetic variability more than single trait. Broad sense heritability was high for most of selection criteria, and higher under normal irrigation than under stress. This could be due to evaluation of the selected families in the same year and location inflated the families' mean squares by the interaction with years and locations. These results agree with those reported by Tang et al. (2009), Hassaballa et al (2012a, b), and Abd ElSameea et al. (2020).

TABLE 4. Means of the studied traits in the F_2 and parents, broad sense heritability (H) and genetic advance (GA) under selection of 10% superior plants under normal irrigation and drought stress in the Egyptian cotton

Item	SCY/ P,g	LY/ P,g	Lint %	NB/p	BW, g	SI, g	LI, g	NS/B	DFF
Normal irrigation									
F_2-generation									
Mean±SE	42.83± 1.33	15.35± 0.52	35.45± 0.17	17.18± 0.40	2.37± 0.02	8.78± 0.05	4.89± 0.05	17.34± 0.1	68.22± 0.15
Max	123.2	48.15	41.62	42.48	3.35	11.7	7.92	24.58	74
Min	12.67	4.56	22.39	5.85	1.5	7	2.39	10.67	57
PCV%	63.91	69.93	9.99	47.44	17.71	11.31	22.03	12.32	4.54
GCV%	34.8	37.39	9.56	25.47	15.88	9.8	20.13	8.97	4.22
H %	29.64	28.59	91.58	28.82	80.43	75.01	83.51	52.95	86.61
GA	9.33	3.66	1.21	2.78	0.14	0.34	0.37	0.73	1.05
GA%	21.78	23.83	3.4	6.03	16.17	3.86	7.51	4.2	1.55
Giza 90 variety									
Mean±	83.38±	32.32±	38.73±	28.33±	2.92±	9.92±	6.28±	18.06±	67.00±
SE	4.62	10.81	0.19	1.36	0.03	0.11	0.09	0.27	0.27
Max	121.4	47.5	40.99	39.16	3.3	10.9	7.18	20.5	71
Min	45	17.4	36.32	16.67	2.6	9.1	5.25	14.46	65
PCV%	27.69	28	2.5	24.05	5.99	5.51	6.79	7.56	2.02
Giza 95 variety									
Mean±	82.31±	31.69±	38.45±	29.03±	2.81±	9.71±	6.07±	17.87±	59.48±
SE	5.11	2.03	0.24	1.55	0.04	0.1	0.1	0.35	0.19
Max	128.1	50.6	40.22	44.17	3.2	10.5	6.96	20.68	61
Min	32.6	13	36.34	12.54	2.5	9	5.36	14.65	58
PCV%	27.74	28.71	2.82	23.88	6.94	4.54	7.38	8.72	1.43
Drought stress									
F_2-generation									
Mean±SE	33.13± 0.85	11.77± 0.33	35.23± 0.16	18.33± 0.38	1.78± 0.02	8.02± 0.03	4.41± 0.04	14.13± 0.12	61.72± 0.13
Red.%	22.65	23.31	0.62	-6.73	24.58	8.65	9.91	18.51	9.54
Max	85.1	33.75	51.73	58.5	2.8	10.4	8.57	19.72	67
Min	12.16	4.19	25.81	7.00	1.00	6.50	2.60	7.83	53
PCV%	51.4	56.18	8.87	41.16	21.02	8.46	18.88	16.69	4.35
GCV%	14.79	15.30	8.05	27.33	15.79	7.77	16.66	11.98	4.00
H %	8.28	5.20	82.4	44.11	56.4	84.38	77.92	51.51	84.64
GA	1.97	0.77	0.36	0.87	0.04	0.08	0.1	0.27	0.31
GA%	5.96	6.51	1.03	2.44	4.77	0.98	2.19	1.93	0.5
Giza 90 variety									
Mean±	56.82±	21.81±	38.20±	24.14±	2.35±	7.94±	4.92±	18.24±	52.93±
SE	3.33	1.36	0.23	1.26	0.06	0.06	0.07	0.39	0.18
Red.%	31.85	32.51	1.36	14.79	19.59	19.96	21.62	-0.97	21
Max	83.8	33.6	40.13	36.14	3.4	8.5	5.62	26.09	54
Min	28.3	10.6	36.13	13.68	1.8	7.5	4.26	14.81	51
PCV%	29.28	31.18	3.06	26.19	11.92	3.57	7.6	10.63	1.74
Giza 95 variety									
Mean±	62.47±	24.19±	38.49±	25.91±	2.38±	7.64±	4.80±	19.13±	51.67±
SE	3.57	1.5	0.32	1.09	0.05	0.06	0.09	0.29	0.26
Red.%	24.11	23.67	0.12-	10.76	15.33	21.28	21.03	7.08-	13.13
Max	85.6	33.6	40.36	32.5	2.7	8.1	5.44	21.44	53
Min	32.3	11.4	35.29	15.14	2	7.1	3.87	16.53	50
PCV%	**25.56**	**27.77**	**3.74**	**18.78**	**8.85**	**3.29**	**8.49**	**6.67**	**2.26**

SE= standard error, PCV% and GCV%= phenotypic and genotypic coefficients of variability; respectively, GA%= GA/mean*100, Red.% (reduction%) = [(mean under normal-mean under stress)/ mean under normal x 100], SCY/p= seed cotton yield/plant, LY/p= lint yield/plant, NB/p= number of bolls/plant, BW= boll weight, SI= seed index, LI= lint index, NS/B= number of seeds/boll, and DFF=days to first flower.

TABLE 5. Correlations among traits in the F_2-generation of Egyptian cotton under normal irrigation (above diagonal) and under drought stress environment (below diagonal)

	SCYg/p	LYg/p	Lint%	NB/p	BW, g	SI, g	LI, g	NS/p	DFF
SCY/p, g	1	0.97**	0.17**	0.97**	0.80**	0.81**	0.60**	0.29**	-0.73**
LY/p, g	0.98**	1	0.32**	0.93**	0.82**	0.84**	0.71**	0.22**	-0.77**
Lint%	0.19**	0.35**	1	0.03	0.33**	0.36**	0.84**	-0.32**	-0.41**
NB/p	0.84**	0.77*	-0.06**	1	0.65**	0.71**	0.44**	0.23**	-0.64**
BW, g	0.63**	0.68**	0.36**	0.15**	1	0.78**	0.67**	0.56**	-0.70**
SI, g	0.59**	0.62**	0.25**	0.61**	0.33**	1	0.80**	0.0004	-0.70**
LI, g	0.44**	0.57**	0.88**	0.56**	0.14**	0.66**	1	-0.19**	-0.67**
NS/B	0.37**	0.39**	0.15**	0.84**	-0.04	0.17**	0.18**	1	-0.14**
DFF	-0.53**	-0.57**	-0.35**	-0.52**	-0.32**	-0.36**	-0.43**	-0.38**	1

*, **; Significant at 5% and 1% level of probability; respectively, SCY/p= seed cotton yield/plant, LY/p= lint yield/plant, NB/p= number of bolls/plant, BW= boll weight, SI= seed index, LI= lint index, NS/B= number of seeds/boll, and DFF= days to first flower.

TABLE 6. Pertinent of mean squares of the studied traits in the F_4 generation of Egyptian cotton selected under normal irrigation (N) and evaluated under both environments

Sel. criterion	Eval env	Item	SCY/p	LY/p	Lint%	NB/p	BW	SI	LI	NS/B	DFF
SCY/p	N	Entries	81.83**	15.61**	1.44**	9.76**	0.13**	0.48**	0.17**	4.69**	7.75**
		Error	7.86	1.22	0.13	0.60	0.003	0.01	0.02	0.18	0.46
	S	Entries	176.02**	56.43**	13.37**	12.04**	0.04*	1.11**	1.73**	3.90*	4.98**
		Error	26.48	2.93	2.29	3.26	0.01	0.09	0.10	0.78	0.72
LY/p	N	Entries	343.46**	58.21**	1.18**	13.87**	0.15**	0.71**	0.30**	3.91**	8.32**
		Error	8.33	1.26	0.13	0.76	0.003	0.01	0.01	0.19	0.46
	S	Entries	225.81**	58.47**	13.76**	16.57**	0.04*	1.26**	1.68**	4.20**	4.54**
		Error	20.19	2.93	1.24	2.86	0.01	0.07	0.05	0.27	0.71
Lint%	N	Entries	1375.71**	207.54**	2.29**	75.93**	0.15**	0.72**	0.63**	5.71**	11.63**
		Error	9.48	1.60	0.22	0.99	0.004	0.01	0.02	0.24	0.68
	S	Entries	731.41**	108.64**	2.44	40.01**	0.23**	0.51**	0.02	10.04**	9.27**
		Error	9.17	0.89	0.92	1.79	0.01	0.01	0.06	0.37	1.72
NB/p	N	Entries	109.98**	24.66**	1.29**	10.14**	0.17**	1.06**	0.54**	3.38*	14.89**
		Error	7.65	1.13	0.16	0.82	0.003	0.01	0.02	0.21	0.56
	S	Entries	396.95**	91.93**	13.05**	23.05**	0.10**	1.08**	1.66**	6.07**	4.63**
		Error	25.24	3.32	1.46	3.18	0.01	0.09	0.07	0.50	0.85
BW	N	Entries	107.66**	17.29**	1.36**	26.07**	0.12**	0.51**	0.17**	4.40*	11.41**
		Error	9.92	1.53	0.12	0.56	0.004	0.01	0.01	0.21	0.56
	S	Entries	446.35**	87.35**	10.73**	22.85**	0.13**	1.13**	1.46**	4.89**	12.41**
		Error	32.07	3.58	2.25	3.99	0.01	0.08	0.09	0.78	0.58
LI	N	Entries	355.65**	57.94**	0.87**	12.69**	0.17**	0.47**	0.28**	5.04**	8.32**
		Error	7.31	1.28	0.13	0.65	0.003	0.005	0.01	0.13	0.44
	S	Entries	220.98**	53.21**	9.60**	16.46**	0.03*	0.78**	1.11**	3.16*	5.30**
		Error	15.28	1.02	2.06	2.15	0.01	0.05	0.10	0.55	0.85
ICL	N	Entries	109.98**	24.66**	1.29**	10.14**	0.17**	1.06**	0.54**	3.38**	14.89**
		Error	7.65	1.13	0.16	0.82	0.003	0.01	0.02	0.21	0.56
	S	Entries	396.95**	91.93**	13.05**	23.05**	0.10**	1.08**	1.66**	6.07**	4.63**
		Error	25.24	3.32	1.46	3.18	0.01	0.09	0.07	0.50	0.85

*, **; Significant at 0.05 and 0.01 levels of probability; respectively. Eval Env= evaluation environment, N= normal irrigation, S= drought stress, SCY/p= seed cotton yield/plant, LY/p= lint yield/plant, NB/p= number of bolls/plant, BW= boll weight, SI= seed index, LI= lint index, NS/B= number of seeds/boll, and DFF= days to first flower, ICL= independent culling levels.

TABLE 7. Pertinent of mean squares of the studied traits in the F_4 generation of Egyptian cotton selected under water stress conditions(S) and evaluated under both environments

Sel. criterion	Eval Env.	Item	SCY/p	LY/p	L%	NB/p	BW	SI	LI	NS/B	DFF
SCY/p	N	Entries	612.27**	65.51**	9.87**	35.23**	0.05	0.79**	1.32*	9.48**	2.86*
		Error	11.65	3.25	1.71	1.56	0.02	0.05	0.13	1.41	0.67
	S	Entries	235.88**	41.30**	1.55**	22.11**	0.03*	0.80**	0.56**	4.50*	10.60**
		Error	10.32	1.55	0.58	1.78	0.01	0.01	0.03	0.39	0.98
LY/p	N	Entries	612.27**	65.51**	9.87**	35.23**	0.05	0.79**	1.32**	9.48**	2.86*
		Error	11.65	3.25	1.71	1.56	0.02	0.05	0.13	1.41	0.67
	S	Entries	235.88**	41.30**	1.55	22.11**	0.03*	0.80**	0.56**	4.50**	10.60**
		Error	10.32	1.55	0.58	1.78	0.01	0.01	0.03	0.39	0.98
L%	N	Entries	1,255.75**	165.42**	4.33*	64.19**	0.14**	1.13**	0.45**	3.34*	10.43**
		Error	16.58	4.83	1.80	4.40	0.02	0.04	0.10	1.33	0.45
	S	Entries	378.50**	73.52**	6.93**	43.20**	0.04*	1.67**	0.77**	7.27**	5.98
		Error	18.59	2.12	1.03	3.73	0.01	0.04	0.08	0.70	3.06
NB/p	N	Entries	2488.57**	375.45**	9.51**	175.27**	0.16**	0.93**	1.22**	13.41**	17.43**
		Error	15.7	4.24	1.69	1.20	0.01	0.09	0.11	0.54	0.57
	S	Entries	756.27**	139.66**	5.41**	87.24**	0.03*	1.52**	0.67**	7.99**	15.68**
		Error	8.33	1.17	1.33	2.50	0.01	0.01	0.06	0.69	2.93
BW	N	Entries	2,108.55**	327.25**	9.05**	125.37**	0.20**	1.30**	1.76**	10.52**	3.49
		Error	11.32	2.48	1.74	2.16	0.02	0.05	0.12	0.94	1.37
	S	Entries	666.12**	119.53**	3.75*	88.46**	0.02	2.18**	0.50**	3.97*	9.94**
		Error	14.56	2.13	0.49	1.81	0.01	0.03	0.04	0.25	1.06
LI	N	Entries	1,492.54**	245.19**	6.99**	86.56**	0.14**	0.56**	0.43*	4.27*	6.05**
		Error	8.65	3.35	2.03	1.97	0.02	0.04	0.13	1.19	0.64
	S	Entries	427.07**	69.03**	1.59	45.91**	0.05**	1.54**	0.89**	9.23**	5.98**
		Error	13.44	1.44	1.31	3.56	0.01	0.03	0.10	0.43	0.63
ICL	N	Entries	612.27**	65.51**	9.87**	35.23**	0.05	0.79**	1.32**	9.48**	2.86*
		Error	11.65	3.25	1.71	1.56	0.02	0.05	0.13	1.41	0.67
	S	Entries	235.88**	41.30**	1.55	22.11**	0.03*	0.80**	0.56**	4.50**	10.60**
		Error	10.32	1.55	0.58	1.78	0.01	0.01	0.03	0.39	0.98

*, **; Significant at 0.05 and 0.01 levels of probability, respectively, Eval Env= evaluation environment, N= normal irrigation, S= drought stress, SCY/p= seed cotton yield/plant, LY/p= lint yield/plant, NB/p= number of bolls/plant, BW= boll weight, SI= seed index, LI= lint index, NS/B= number of seeds/boll, and DFF= days to first flower, ICL= independent culling levels.

TABLE 8. Genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability in broad (H) and in narrow sense (h^2) for the selection criteria in the F_4- generation of Egyptian cotton

Sel Env.	Eval Env.	Item	SCY/p	LY/p	Lint%	NB/p	BW	LI
N	N	GCV%	4.24	9.75	2.09	4.92	6.05	3.89
		PCV%	4.46	9.86	2.2	5.13	6.15	3.91
		H%	90.4	97.84	90.56	91.93	96.74	98.96
		h^2	0.55	0.97	0.59	0.47	0.10	0.04
	S	GCV%	9.41	15.74	1.86	9.55	7.89	5.45
		PCV%	10.21	16.15	2.36	10.29	8.05	5.61
		H%	84.95	95	62.35	86.2	96.13	94.16
		h^2	0.12	0.07	0.08	0.13	0.07	0.16
S	N	GCV%	12.6	10.99	2.41	23.32	8.25	3.98
		PCV%	12.72	11.27	3.15	23.4	8.62	4.13
		H%	98.1	95.05	58.52	99.32	91.55	93.13
		h^2	0.07	0.10	0.01	0.01	0.11	-0.20
	S	GCV%	11.37	12.26	3.66	21.63	2.36	7.69
		PCV%	11.63	12.49	3.97	21.95	2.88	7.77
		H%	95.62	96.26	85.15	97.14	67.11	97.78
		h^2	0.15	0.25	0.57	0.15	0.04	0.04

Sel. Env. = selection environment, Eval. Env. = Evaluation environment, S= drought stress, N= normal irrigation, SCY/p=seed cotton yield/plant, LY/p=lint yield/plant, NB/p=number of bolls/plant, BW=boll weight, SI=seed index, LI= lint index.

TABLE 9. Genotypic (GCV) and phenotypic (PCV) coefficients of variation, heritability in broad(H) and in narrow sense (h^2) for ICL method in the F_4–generation of Egyptian cotton

Sel Env.	Eval Env.	Item	SCY/p	LY/p	Lint%	NB/p	BW	LI
N	N	GCV%	5.01	6.13	1.57	4.92	7.18	6.31
		PCV%	5.2	6.28	1.68	5.13	7.25	6.41
		H%	93.05	95.41	87.8	91.93	98.01	97.09
		h^2	0.75	0.60	0.16	0.47	0.71	-0.24
	S	GCV%	15.69	20.84	5.37	9.55	6.66	13.89
		PCV%	16.21	21.23	5.7	10.29	6.86	14.18
		H%	93.64	96.39	88.8	86.2	94.35	96.02
		h^2	0.38	0.24	0.86	0.39	0.65	1.41
S	N	GCV%	12.6	10.99	4.44	9.33	3.08	10.33
		PCV%	12.72	11.27	4.88	9.54	4.18	10.87
		H%	98.1	95.05	82.69	95.58	54.21	90.37
		h^2	1.81	0.99	0.07	1.74	0.92	0.03
	S	GCV%	11.37	12.26	1.46	8.97	2.99	7.54
		PCV%	11.63	12.49	1.85	9.35	3.52	7.72
		H%	95.62	96.26	62.82	91.95	71.87	95.5
		h^2	0.33	0.37	0.04	0.17	0.51	0.47

Sel.Env. = selection environment, Eval. Env. = Evaluation environment, S= drought stress, N= normal irrigation, SCY/p=seed cotton yield/plant, LY/p=lint yield/plant, NB/p=number of bolls/plant, BW=boll weight, SI=seed index, LI= lint index..

Narrow sense heritability as estimated by regression of offspring on parents was mostly higher under normal evaluation than under stress, either selection was done under normal irrigation or under stress.

Mean, direct observed genetic gain for single trait selection

The direct observed genetic gain after two cycles of selection for SCY/p under normal irrigation environment was positive and significant (P≤0.01) from the mid-parent (16.91%) and better parent (13.96%) under normal irrigation evaluation, but the evaluation under drought stress showed significant gain from the mid-parent (8.9%) and insignificant from the better parent (Table 10). Otherwise, selection under drought stress environment gave significant gain (P≤0.01) from the mid-parent of 12.05% and 10.69% under irrigation and drought stress evaluation, respectively, and significant gain from better parent (9.22%) only under normal irrigation. Selection for LY/p showed the same trend in which selection under normal irrigation showed the best performance under normal irrigation, and selection under stress gave the best performance under drought stress. Selection for BW and LI confirmed this concept. These results agree with the opinion of selection under the environment of production. However, Richards (1996) and Betrán et al. (2003) suggested selection under favorable environment, and some believe in selection under typical drought conditions (Ceccarelli, 1987; Ceccarelli & Grando, 1991b). Many researchers believe in selection under both favorable and stressed conditions. Keim & Kronostad (1979) proposed that, an ideal cultivar for stress-prone environments should have high yield in the most severely stressed environment expected, and a strong response (b>1) to more favorable environments. Ceccarelli & Grando (1991a, b) indicated that selection environment affects the performance of barley materials. The higher stability genotypes were selected under low yielding environment. Falconer (1990) reviewed experiments and indicated that antagonistic selection was significantly better than synergistic for changing the mean.

Independent culling levels method of selection (ICL)

The ICL method of selection included six traits: seed cotton yield/plant, lint yield/plant, lint %, number of bolls/plant, boll weight, and lint index (Table11). The ICL method of selection under drought stress was better than under normal irrigation, seed cotton yield/ plant, LY/p, lint %, NB/p, BW and LI performed well under drought stress than under normal irrigation.

TABLE 10. Means, direct observed genetic gain after two cycles of single trait selection in percentage from the mid-parent (OG% "MP") and the better parent (OG%"BP") under drought stress(S) and normal irrigation (N) of Egyptian cotton

Sel Env.	Eval Env.	Item	SCY/p	LY/p	Lint%	NB/p	BW	LI
N	N	Mean C_2	117.15	44.69	39.73	35.86	3.27	6.67
		OG%(MP)	16.91**	16.98**	4.21**	4.68**	11.91**	8.25**
		OG%(Bp)	13.96**	13.71**	3.91**	4.64**	9.11**	7.67**
	S	Mean C_2	75.05	27.33	38.23	28.60	2.61	5.50
		OG%(MP)	8.90*	7.76*	3.90**	4.24	4.12	14.55**
		OG%(Bp)	3.94	1.99	2.99	1.81	1.69	14.08**
S	N	Mean C_2	112.27	41.46	38.13	35.49	2.99	6.36
		OG%(MP)	12.05**	8.53**	0.03	3.59	2.34	3.23
		OG%(Bp)	9.22**	5.50*	-0.25	3.56	-0.22	2.67
	S	Mean C_2	76.27	29.70	38.31	28.47	2.67	5.69
		OG%(MP)	10.69**	17.09**	4.11**	3.75	6.24**	18.53**
		OG%(Bp)	5.64	10.82**	3.19	1.34	3.76	18.04**

Sel. Env= selection environment, Eval. Env= evaluation environment, SCY/p= seed cotton yield/plant, LY/p= lint yield/plant, NB/p= number of bolls/plant, BW= boll weight, SI= seed index, LI= lint index, *, **; significant at 5% and 1% level of probability, respectively.

TABLE 11. Means, direct observed genetic gains after two cycles of ICL selection method in percentage from the mid-parent (OG% "MP") and the better parent (OG%"BP") under drought stress (S) and normal irrigation (N) of Egyptian cotton

Sel Env.	Eval Env.	Item	SCY/p	LY/p	Lint%	NB/p	BW	LI
N	N	Mean C_2	109.56	40.22	36.83	35.49	3.07	5.83
		OG%(MP)	9.34**	5.29*	-3.39	3.59	5.07**	-5.38
		OG%(Bp)	6.58	2.34	-3.67	3.56	2.44	-5.89
	S	Mean C_2	69.47	26.47	37.98	28.47	2.45	5.58
		OG%(MP)	0.81	4.37*	3.24*	3.75	-2.52	16.21**
		OG%(Bp)	-3.79	-1.22	2.33	1.34	-4.80	15.72**
S	N	Mean C_2	112.27	41.46	37.14	35.91	3.12	6.10
		OG%(MP)	12.05**	8.53**	-2.56	4.84*	6.67*	-1.03
		OG%(Bp)	9.22**	5.50**	-2.84	4.81	4.00*	-1.56
	S	Mean C_2	76.27	29.70	38.89	29.03	2.63	5.61
		OG%(MP)	10.69**	17.09**	5.71**	5.80*	4.65*	16.85**
		OG%(Bp)	5.64	10.82**	4.78**	3.33	2.20	16.36**

Sel. Env= selection environment, Eval. Env= evaluation environment, SCY/p= seed cotton yield/plant, LY/p= lint yield/plant, NB/p= number of bolls/plant, BW= boll weight, SI=seed index, LI= lint index. *, **; significant at 5% and 1% level of probability, respectively.

Finally, it could be concluded that the results of single trait selection proved that selection under optimum environment performed well under optimum, and selection under drought stress was better under stress. Otherwise, ICL method of selection did well under drought stress. Tang et al. (2009) indicated that the efficiency of the selection index consisting of lint yield/plant, bolls/plant, number of boll position was higher than that of selection for lint yield/plant alone by 12.06%. NaiYin & Jian (2014) and El-Dahan (2016) stated that selection index was better than single trait selection.

Conclusion

The minimum and maximum values for all traits in the F_2-generation located outside the parental values for yield and yield components indicating the feasibility of selection. Such wide variability in SCY/p with broad sense heritability of 29.64 and 8.28% resulted in predicted genetic advance in percentage of the mean of 21.78 and 5.96% under normal irrigation and drought stressed environment, respectively. Except for BW and NS/B the PCV% was higher under normal irrigation than under drought stress. The correlations among traits indicated that SCY/p depended mainly upon NB/p, BW and SI, and moderately on LI. Days to first flower showed negative correlation with all traits under both environments. Genotypic and phenotypic coefficients of variability were greatly depleted by selection from the F_2 to F_4- generations. The PCV and GCV of the selection criteria in the F_4 were higher in most cases under drought stress than under normal irrigation when selection practiced under both environments. This confirms the view that under poor or adverse environment the differences between genotypes can be detected. The ICL method preserved genetic variability more than single trait selection. The broad sense heritability was high for most of selection criteria and higher under normal irrigation than under stress. The rise in the broad sense heritability could be due to that the selection and evaluation were in one environment which inflated the families' mean squares. Narrow sense heritability as estimated by regression of offspring on parents was mostly higher under normal evaluation than under stress. It could be concluded that the results of single trait selection proved that selection under optimum environment performed well under optimum, and selection under drought stress was better under stress. These results agree with the opinion of selection under the environment of production. Otherwise, ICL method of selection did well under drought stress.

References

Abdelraheem, A., Esmaeilib, N., O'Connella, M., Zhang. J. (2019) Progress and perspective on drought and salt stress tolerance in cotton. *Industrial Crops and Products*, **130**, 118–129.

Abd ElSameea, A.A., Ibrahim, M.M., Ahmad, M.S.H., ELTahan, S.A. (2020) Pedigree selection for lint yield in two segregation populations of Egyptian cotton (*Gossypium barbadense* L.). *World Journal of Agriculture and Soil Science*, **5**(4),1-8.

Ahmad, R.T., Malik, T.A., Khan, I.A., Jaskani, M.J. (2009) Genetic analysis of some morpho-physiological traits related to drought stress in cotton (Gossypium hirsutum). *International Journal of Agriculture and Biology*, **11**(3), 235–240.

AL-Ameer, M., AL-Hibbiny, Y.I.M., Yehia, W.M.B. (2015) Evaluation of Some Genotypes in Cotton Under Stress of Longevity of the Periods of Irrigation. *Journal of Agricultural Chemistry and Biotechnology*, **6**(6), 191–218.

Amein, M.M.M., Masri, M.I., EL-Adly, H.H., Attia, S.S. (2020) Correlation and path analysis for yield components traits in Egyptian cotton genotypes (*Gossypium barbadense* L.). *Plant Archives*, **20**, 803-806.

Batista, L.G., Gaynor, R.C., Margarido, G.R.A., Byrne, T., Amer, P., Gorjanc, G., Hickey, J.M. (2021) Long-term comparison between index selection and optimal independent culling in plant breeding programs with genomic prediction', *PLoS ONE*, **16**, 1–5.

Betrán, F.J., Beck, D., Banziger, M., Edmeades, G.O. (2003) Genetic analysis of inbred and hybrid grain yield under stress and nonstress environments in tropical maize. *Crop Science*, **43**(3), 807.

Blake, G.R., Hartge, K. H. (1986) Bulk Density. In: "*Methods of Soil Analysis. Part 1 - Physical and Mineralogical Methods*", A. Klute (Ed.), 2nd ed. American Society of Agronomy, Madison WI.

Bucio Alanis, L., Hill, J. (1966) Environment and genotype – environmental components of variability II. Heterozygotes. *Heredity*, **21**, 399-405.

Ceccarelli, S. (1987) Yield potential and drought tolerance of segregating populations of barley in contrasting environments. *Euphytica*, **36**(1), 265–273.

Ceccarelli, S., Grando, S. (1991a) Selection environment and environmental sensitivity in barley. *Euphytica*, **57**(2), 157–167.

Ceccarelli, S., Grando, S. (1991b) Environment of selection and type of germplasm in barley breeding for low-yielding conditions. *Euphytica* **57**, 207-219.

Dahab, A.H., Mohamed, B.B., Husnain, T., Saeed, M.M. (2012) Variability for drought tolerance in cotton (*Gossypium Hirsutum* L.) for growth and productivity traits using selection index. *African Journal of Agricultural Research,* **7**(35), 4934-4942.

El-Dahan, M.A.A. (2016) Comparison among some selection procedures to produce the nucleolus (breeder seed) of the egyptian cotton variety giza 92 (*Gossypium barbadense* L). *Journal of Sustainable Agricultural Sciences*, **42**(4), 455–470.

El-Fesheikawy, A., Abd El-Salam, M., Ramdan, B. (2014) Aplication of some selection indices in early segregating generations of Barbadense cotton. *Journal of Plant Production*, **5**(7), 1317–1329.

Falconer, D.S. (1989) "*Introduction to Quantitative Genetics*". 3rd ed., Longman Scientific and Technical, New York.

Falconer, D.S. (1990) Selection in different environments: Effects on environmental sensitivity (reaction norm) and on mean performance. *Genetical Research*, **56**(1), 57–70.

Gao, M., Snider, J.L., Bai, H., Hu, W., Wang, R., Meng, Y., Wang, Y., Chen, B., Zhou, Z. (2020) Drought effects on cotton (*Gossypium hirsutum* L.) fibre quality and fibre sucrose metabolism during the flowering and boll-formation period. *Journal of Agronomy and Crop Science*, **206**(3), 309–321.

Gee, G.W., Bauder, J.W. (1986) Particle size analysis. In: "*Methods of Soil Analysis Part 2: Chemical and Microbiological Properties*", Page, A.L., R.H. Miller and D.R. Keeney (Eds.), 2nd ed. Agronomy Society of America, Madison, WI.

Hassaballa, E.A., Mahdy, E.E., Mohamed, A.A., Aly, A.M. (2012a) Selection for earliness index in two segregating populations of Egyptian cotton (*G. barbadense* L.) under late planting., *Assiut Journal of Agricultural Sciences*, **43,** 1–17.

Hassaballa, E.A., Mahdy, E.E., Mohamed, A.A., Aly, A.M. (2012b) Pedigree selection for lint yield at late planting in Egyptian cotton (*G. barbadense* L.). *Journal of Production and Development*, **17**(2), 419-430.

Ibrahim, N. Abou-Elwafa, S.F., Mahrous, H., Ismail, A.A., Mahdy, E.E. (2017) Efficiency of single and multiple traits selection for yield and its components in varietal maintenance of Giza 90 Egyptian cotton variety. *World Journal of Agricultural Research*. **4**(6),166-172.

Iqbal, M., Khan, M.A., Naeem, M. (2013) Inducing drought tolerance in upland cotton (*Gossypium hirsutum* L.), accomplishments and future prospects. *World Applied Sciences Journal*, **21**(7), 1062–1069. .

Israelsen, O.W., Hansen, V.E. (1962) "*Flow of Water into and Through Soils. Irrigation Principles and Practices*". 3rd ed., John Wiley and Sons, Inc., New York, N. Y., U.S.A.

Jinks, J.L., Connolly, V. (1973) Selection for specific and general response to environmental differences. *Heredity*, **30**(1), 33–40.

Jinks, J.L., Connolly, V. (1975) Determination of environmental sensitivity of selection lines by the selection environment. *Heredity*, **34**. 401-406.

Joshi, V., Patil, B.R. (2018) Correlation and path coefficient analysis in segregating population of Upland cotton (*Gossypium hirsutum* L.). *International Journal of Current Microbiology and Applied Sciences*, **7**(08), 125–129.

Kamaran, S., Imran, M., Khan, T.M., Munir, M.Z., Rashid, M.A., Muneer, M.A. (2016) Genetic studies of genotypic responses to water stress in upland cotton (*Gossypium hirsutum* L.). *International Journal of Agronomy and Agricultural Research*, **8**(6), pp. 1–9.

Kassem, M.M., Sary, G.A., El-Okkiah, A.F.H., 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,* **86**, 623-629.

Keim, D.L., Kronstad, W.E. (1979) Drought resistance and dryland adaptation in winter wheat. *Crop Science,* **19**, 574-576.

Mabrouk, A.H. (2020) Application of some selection procedures for improving of some economic characters in cotton (*G. Barbadense* L.). *Menoufia Journal of Plant Production*, **5**(8), 365–383.

Mahdi, A., Emam, S. (2020) Correlation and path coefficient analysis of some earliness measures in Egyptian cotton. *Journal of Plant Production*, **11**(5), 407–501.

Mahdy, E.E., Hemaida, G.M.K., Abd El-Motagally, F.M.F., Mostafa, A. (2009a) Response to selection for yield under late sowing date in two populations of Egyptian cotton. *Assiut Journal of Agricultural Sciences,* **40**(Special Issue), 1-25.

Mahdy, E.E., Hemaida, G.M.K., Abd El-Motagally, F.M.F., 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,* **29**, 233-258.

Mussell, H., Staples, R.C. (1979) "*Stress Physiology in Crop Plants*". New York: John and sons. New York.

NaiYin, X., Jian, L. (2014) Identification of ideal test environments for multiple traits selection in cotton regional trials. *Acta Agronomica Sinica,* **40**(11), 1936-1945.

Nawaz, B., Sattar, S. Malik, T.A. (2019) Genetic analysis of yield components and fiber quality parameters in Upland cotton. *International Multidisciplinary Research Journal,* **9**, 13-19.

Pettigrew, W.T. (2004a) Moisture deficit effects on cotton lint yield, yield components, and boll distribution. *Agronomy Journal,* **96**, 377–383.

Pettigrew, W.T. (2004b) Physiological consequences of moisture deficit stress in cotton. *Crop Science*, **44**(4), 1265–1272.

Rehman, M., Bakhsh, A., Zubair, M., Rehmani, M.I. A., Shahzad, A., Nayab, S.F., Khan, M.M., Anum, W., Akhta, R., Kanwal, N., Manzoor, N., Ali, I. (2021) Effects of water stress on cotton (*Gossypium* spp.) plants and productivity. *Egyptian Journal of Agronomy*, **43**(3), 307–3015.

Richards, R.A. (1996) Defining selection criteria to improve yield under drought. *Plant Growth Regulation*, **20**(2), 157–166.

Singh, P. (2004) "*Cotton Breeding*". 2nd ed. Kalyani Publishers. New Dehli India.

Smith, J.D., Kinman, M.L. (1965) The use of parent-offspring regression as an estimator of heritability. *Crop Science,* **5**, 595-596.

Soliman, A. (2018) Maintenance and producing of the nucleolus (Breeder's Seed) of Giza 90 Egyptian cotton cultivar (*Gossypium barbadense* L.). *Journal of Plant Production*, **9**(6), 567–571.

Steel, R.G.D., Torrie, J.H., Dicky, D.A. (1997) "*Principles and Procedures of Statistics. A Biometrical Approach*". 2nd ed. McGraw Hill Book Company. Inc. New York, NY.

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

Yan, W. (2021) A systematic narration of some key concepts and procedures in plant breeding. *Frontiers in Plant Science,* **12**, 724517. doi: 10.3389/fpls.2021.724517

Zhang, J., Hughs, S.E. (2012) Effects of soil salinity and plant density on yield and leaf senescence of field-grown cotton. *Journal of Agronomy and Crop Science*, **198**(1), 27–37.

تحسين القطن المصري (جوسيبيوم باربادنس ل) بالانتخاب للصفات المفردة والانتخاب بالمستويات المستبعدة تحت ظروف نقص الماء والري العادي

عزت السيد مهدى[1]، صلاح فتوح ابو الوفا[1]، جمال عبد الظاهر[2]، نور الدين عبد الرحمن[2]

[1] قسم المحاصيل - كليه الزراعة- جامعه اسيوط- اسيوط- مصر، [2]معهد بحوث القطن- مركز البحوث الزراعية- الجيزة - مصر.

تعد التربية التقليدية أحد الطرق الهامة في استنباط اصناف مقاومه للجفاف. وهناك حاجه ماسه لاستنباط اصناف قطن تعطى محصولا مقبولا سواء تحت ظروف نقص الماء او البيئة الجيدة. وتهدف هذه الدراسة الى مقارنه الانتخاب لست صفات مفرده مع الانتخاب لنفس هذه الصفات بالمستويات المستبعدة لتحسين محصول القطن الزهر للنبات تحت ظروف الري العادي وظروف نقص الماء. واستخدم فى ذلك الجيل الثاني للهجين (جيزة 90/ جيزه95) (وهي اصناف طويله التيلة تتبع جوسيبيوم باربادنس). لوحظ ان معامل الاختلاف الوراثي والمظهري في الجيل الثاني كانا اعلى تحت ظروف الري العادي عنه تحت ظروف الجفاف. وتوضح نتائج الارتباط بين الصفات في الجيل الثاني ان صفه محصول القطن الزهر للنبات تعتمد اساسا على عدد اللوز على النبات ووزن اللوزة ومعامل البذرة وبدرجه متوسطه على معامل الشعر، وكانت النباتات المبكرة عالية الارتباط بالمحصول. ووجد ان معامل الاختلاف المظهري والوراثي قد انخفضا بشده بتأثير الانتخاب، وعموما كانا أعلى تحت ظروف الجفاف عن الري العادي. كما وجد ان طريقه الانتخاب بالمستويات المستبعدة أكثر قدره على الحفاظ على التباين الوراثي عن الانتخاب للصفات المفردة. وكان معامل التوريث بالمعنى الضيق عاده أعلى تحت ظروف الري العادي عن ظروف الجفاف. وفى الجيل الرابع قيمت منتخبات الري تحت ظروف البيئتين وكذللك منتخبات الجفاف سواء منتخبات الصفات المفردة او منتخبات طريقه المستويات المستبعدة. ادى الانتخاب تحت ظروف الري الى زيادة محصول القطن الزهر تحت ظروف الري بمقدار 16.9% وتحت ظروف الجفاف بمقدار 8.90%، اما الانتخاب تحت ظروف الجفاف ادى لزيادة محصول القطن الزهر بمقدار 12.05% تحت ظروف الري، 10.69% من متوسط الابين تحت ظروف الجفاف. وتوضح النتائج ان أداء الانتخاب للصفات المفردة تحت ظروف الري كان أفضل تحت ظروف الري، والانتخاب تحت ظروف الجفاف كان أداؤه افضل تحت ظروف الجفاف. أما الانتخاب بالمستويات المستبعدة كان اداؤه أفضل تحت ظروف الجفاف.