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SELECTION FOR EARLINESS IN BREAD WHEAT UNDER NORMAL IRRIGATION AND DROUGHT STRESS CONDITIONS

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ABSTRACT

To estimate the efficiency of single trait selection for days to heading in the F_4, F_5 and F_6-generations of population (Giza 168 × Sids 4) (*Triticum aestivum* L.) two experiments conducted under normal irrigation and drought stressed environments. Mean squares in F_4 and F_6-generations of all the studied traits were significant ($p<0.01$) for the selected families to days to heading under both environments. The pcv and gcv % tended to be low under the two environments and close to each other, which resulted in high estimates of broad sense heritability; 98.49 and 98.06 and high estimates of expected genetic advance of 11.72 and 10.27% of the F_4-mean under normal and stressed environments; respectively. After two cycle of pedigree selection for days to heading the gcv and pcv was 6.03 and 6.15 compared to 6.42 and 6.47% in the F_4 under irrigation, and was 4.46 and 4.61 compared to 5.63 and 5.69% in the F_4-generation under drought stress; respectively. The average direct gain was significant ($p<0.01$) and reached -16.36 and -10.17% from the bulk sample under normal irrigation and drought stress environments; respectively. Average direct gain in percentage of the earlier parent Sids4 was significant ($p<0.05$) under normal irrigation (-2.55%), but, insignificant (-1.39%) under drought stress. On the level if individual families four families (No.44, No.48, No.68 and No.147) showed significant ($p<0.01$) earliness than the earlier parent Sids4 under normal irrigation. However, under drought stress two families out of ten (No.63 and No.147) showed significant ($p<0.05$) earliness from Sids4 and showed significant observed gain in grain yield/plant from the better parent, and could be considered the best families. These results indicate that selection for earliness was more effective under normal irrigation than under drought stress in detecting the early family. The genotypic correlation of DH with GY/P was very weak in both of the F_4 and F_6-generations, but, changed from 0.02 to -0.09. Meaning that early families slight increased grain yield/plant under normal irrigation.

Keywords: Bread wheat, Drought stress, Heritability and Selection for earliness.

INTRODUCTION

Earliness is an important goal in plant breeding. Early mature wheat cultivars are highly needed to crop intensification as planting cotton after wheat and planting wheat after harvesting short duration vegetable crops, etc. Also, early cultivars are also preferred to escape from drought, heat, diseases, pests and injuries that occur at the end of the growing season (Menshawy., 2007). Early heading cultivars out performed later heading cultivars because of two distinct advantages, the early heading cultivars had longer post-heading and, therefore, longer grain filling period than the later heading cultivars. In addition, early-heading cultivars completed a greater fraction of the grain filling earlier in the season when air temperatures were lower and generally more favorable (Tewolde *et al*. 2006). Early cultivars could be suitable for cultivation at the northern cost of Egypt (rainfall ranged from 150 to 200 mm/year) with supplement of one irrigation.

Pedigree selection method has become the most popular of the plant breeding procedures. Most of the Egyptian wheat cultivars were produced through this method. It is preferred by plant breeders because it is versatile, relatively rapid and makes possible conducting of genetic studies along with the plant breeding work (Mahdy, 2012b). El-Morshidy *et al.* (2010) found high broad sense heritability values for days to heading under normal and water stress in F_4-generation. Mahdy *et al.* (2012a) observed the pcv decreased rabidly by selection for days to heading from 10.88 in F_3 to 7.99 in F_4-generation. Ali (2011) revealed that pedigree selection for either earliness was effective in isolating genotypes for early heading. El-Ameen (2012) observed indirect response to selection for early families, significant positive correlated responses to selection were obtained in grain yield (12.63%).Ali and Abou-El-wafa (2006), Ali (2011) found that selection for days to heading decreased grain yield/plant. Kilic and Yagbasanlar (2010), Bilgin *et al.* (2011) and Subhani *et al.* (2011) noted negative correlation of grain yield with days to heading. Meaning that early families slight increased grain yield/plant. The objective of this study was to estimate the efficiency of single trait selection for earliness in segregating population (Giza 168 × Sids 4) (*Triticum aestivum* L.) under normal irrigation and drought stressed environments.

MATERIALS AND METHODS

The present work was carried out during the period of 2011/2012 – 2013/2014 seasons at Fac. Agric. Edu. Farm, Minia University, Egypt. The basic materials consisted of 240 families in the F_4-generation derived from the segregating population (Giza 168 x Sids 4).The families were planted in two separated experiments for normal irrigation and drought conditions. The recommended cultural practices for wheat production were adopted throughout the growing seasons except irrigation which was applied as follows:

1- First experiment (normal irrigation) in which the families were irrigated six times.
2- Second experiment (drought) in which the families were irrigated only two times (planting irrigation and another one three weeks later).

Table1. The pedigree of the parents of the wheat population

Parental cultivars	Pedigree
Giza 168	MIL/Buc//Seri CM93046-8M-04-0M-2Y-0B
Sids 4	Maya (S)/Man (S)//CMH 74A-592/3/Giza 157*2

In 2011/2012 season, The 240 F_4-families were grown in Nov.28th in two separated experiments (irrigation and drought conditions) along with the two parents and the unselected bulk sample. The bulk sample consisted of a mixture of equal number of grains from each family. A randomized complete block design of three replications was used. The plot size was one row, 1.5m long, 30cm apart and 5cm between grains within the row. At the end of the season, the earliest 20 plants from the earliest 20 families were saved.

In 2012/2013 season, the 20 selected plants (F_5-generation) along with the two parents and bulk sample were sown on Nov.14th in two separate experiments. The experimental design and plot size were as in the previous season except for the distance between plants in a row was 10 cm. the earliest 10 plants from the earliest 10 families were saved.

In 2013/2014 season, the 10 selected families (F_6-generation) were evaluated and sown on Nov.20th in two separate experiments as in the previous season.

In the F_4, F_5 and F_6-generations data were collected on ten guarded plants per row from each family; hence the mean of the ten plants was calculated. The studied traits were as follows: days to heading [DH], plant height [PH] in cm, spike length [SL] in cm., number of spikes/plant (NS/P), number of grains/spike (NG/S), weight of grains/spike in g.(WG/S), 100-grain weight [100-GW] in g. biological yield/plant [BY/P] in g., grain yield/plant [GY/P] in g., and harvest index% [HI].

Data were subjected to proper statistical analysis of RCBD according to Steel and Torrie (1980) on plot mean basis.

Table 2.The form of analysis of variance, covariance and their expectations.

S. O. V.	d.f	M. S.	E. M. S.	
			Variance	Covariance
Replications	r-1	M_3	σ^2 e + g σ^2 r	
Genotypes	g-1	M_2	σ^2 e + r σ^2 g	cov.e + r cov.g
Error	(r-1) (g-1)	M_1	σ^2 e	cov.e

where: r and g are number of replications and genotypes; respectively, σ^2 e and cov.e are error variance and covariance; respectively, and σ^2 g and cov.g are genetic variance and genetic covariance; respectively. Two analysis of variance were done. The first, was for all entries (selected families + parents + bulk sample), and the second one was for the selected families to calculate heritability, genotypic and phenotypic coefficients of variations.

The phenotypic (σ^2p) and genotypic (σ^2g) variances were calculated according to the following formula:

$$\sigma^2 g = (M_2-M_1) / r. \qquad \sigma^2 p = \sigma^2 g + \sigma^2 e /r.$$

Heritability in broad sense “H” was estimated as σ^2 g / σ^2 p according to Walker (1960).

Realized heritability (h^2) was calculated as: h^2 = R / S (Falconer, 1989)
where R = response to selection and S = selection differential.

The phenotypic (pcv %) and genotypic (gcv %) coefficients of variability were calculated as outlined by Burton (1952), as follows:

$$pcv\ \% = \sigma p / \bar{x} . 100. \qquad gcv\ \% = \sigma g / \bar{x} . 100.$$

where: σp and σg are the phenotypic and genotypic standard deviation of the families mean, respectively, and $\bar{x}$ is families mean for a given trait.

Estimates of heritability in broad sense (H), pcv and gcv % were base on number of families, only.

The calculation of the phenotypic covariance (cov.p_{12}), and genotypic covariance (cov.g_{12}) between pairs of traits (1 and 2) followed the same form as variance analysis.

Genotypic correlation coefficient (rgxy) was calculated as outlined by Walker (1960) as follows: **$rg_{xy} = covg_{xy} / (\sigma g_x . \sigma g_y)$.**

Mean comparisons were calculated by using revised L.S.D where, L.S.D = least significant difference, at 0.05 and 0.01 level of probability, according to El-Rawi and Khalafala (1980) and was calculated as:

RLSD Family = $t' . \sqrt{2Mse/r}$ to compare families with the better parent and the bulk sample.

RLSD Average = $t' . \sqrt{Mse/r + Mse/fr}$ to compare average with the better parent and the bulk sample.

The significance of observed direct and correlated response to selection was measured as deviation percentage of families mean from the bulk or the better parent using L.S.D. where, L.S.D = least significant difference between mean of the selected families and the bulk or the better parent, and was calculated as:

LSD Family = $t . \sqrt{2Mse/r}$ to compare families with the better parent and the bulk sample.

LSD Average = $t . \sqrt{Mse/r + Mse/fr}$ to compare average with the better parent and the bulk sample.

LSD % = (LSD value / the bulk or the better parent)*100

Where f= number of families, r= number of replicates and t' is the t value from " minimum-average-risk t-table" at F-value of treatments, treatment d.f. and experimental error d.f.

RESULTS AND DISCUSSION

1- Description of the base population

Mean squares in F_4-generation (Tables 3 and 4) of all the studied traits were significant (p<0.01) under normal irrigation and stressed environments indicating the presence of variability in the criteria of selection, days to heading. Similar results were observed by El-Morshidy *et al.* (2010), Ferdous *et al.* (2011), Subhani *et al.* (2011), Mahdy *et al.* (2012b).

Days to heading ranged from 52.67 and 109.00 with an average of 87.30 under normal irrigation, which fell outside the range of the two parents (Table 3), and showed nearly complete dominance towards the later parent Giza 168 (86.00 day). Means under drought stressed showed the same trend

(Table 4). Furthermore, days to heading under stressed (86.94) and non-stressed environments (87.30) were fairly the same indicating that two irrigations in clay soil (planting irrigation and first irrigation) did not affect days to flowering, because of the high water holding capacity of the clay soil. The results indicated that the families mean under drought (86.94) exceeded significantly (p<0.01) the later parent Giza 168 (83.33) indicating over dominance towards lateness.

Table 3. Mean squares of the studied traits for the 240 families in F4-generation under normal irrigation, family mean, the parents and the bulk sample, phenotypic(pcv) and genotypic (gcv) coefficients of variability, expected genetic advance (ΔG) and heritability in broad sense (H).

Items	d.f	DH	PH	SL	NS/P	100-GW	NG/S	WG/S	BY/P	GY/P	HI%
MS Rep	2	2.00	12.42	0.14	2.93	0.70	6.63	2.51	36.93	9.62	8.65
MS Entries	242	102.2**	191.93**	7.15**	2.98**	0.32**	428.71**	1.56**	202.41**	37.64**	49.01**
MS Error	484	1.43	4.93	0.44	0.81	0.24	10.34	0.25	6.76	1.53	6.99
Mean ± SE		87.30± 0.37	92.07± 0.51	13.75± 0.10	6.67± 0.05	5.50± 0.01	67.92± 0.76	3.77± 0.04	51.13± 0.52	19.82± 0.22	38.91± 0.24
Min		52.67	73.67	10.00	4.48	4.64	44.55	2.47	29.21	10.42	25.78
Max		109.00	117.33	18.00	11.36	6.96	113.74	6.66	74.47	30.68	48.73
g.c.v%		6.42	8.58	10.88	12.30	3.12	17.42	17.56	15.58	17.28	9.69
p.c.v%		6.47	8.69	11.23	14.59	6.03	17.64	19.17	15.85	17.65	10.43
H%		98.49	97.46	93.84	71.05	26.78	97.60	83.91	96.58	95.85	86.17
ΔG		10.23	14.35	2.67	1.27	0.16	21.52	1.12	14.40	6.17	6.44
ΔG/mean%		11.72	15.59	19.39	19.08	2.97	31.68	29.61	28.17	31.14	16.55
Giza 168		86.00	94.00	15.11	5.06	5.38	59.34	2.97	37.44	13.08	35.25
Sids 4		65.00	79.78	16.00	3.80	5.71	70.75	4.03	35.54	14.03	39.49
Bulk		75.67	86.83	12.92	4.71	5.17	53.57	2.91	36.59	14.07	38.55
RLSD Aver0.05		1.19	2.26	0.70	1.10	0.76	3.20	0.55	2.65	1.26	2.89
RLSD Aver0.01		1.56	2.97	0.92	1.37	1.54	4.19	0.72	3.47	1.65	3.81

***,** significant at 0.05 and 0.01 levels of probability; respectively.**
ΔG = expected genetic advance from selection the superior 8.33% of the families.
RLSD. Aver. = to compare families mean with the bulk sample or the better parent.

The phenotypic and genotypic coefficients of variability tended to be low under the two environments and close to each other, which resulted in high estimates of broad sense heritability; 98.49 under normal irrigation and 98.06 under stressed environment. El-Morshidy *et al.* (2010) found high broad sense heritability for days to heading under normal and water stress in F_4-generation. The high estimates of heritability obtained resulted in high estimates of expected genetic advance of 11.72 and 10.27% of the F_4-mean under normal and stressed environments; respectively. It should be indicate that under normal irrigation the minimum days to flowering was 52.67 was significant (p<0.01) earlier than the earlier parent Sids 4 (65.00) indicating transgressive segregation. However, under drought stress Sids 4 (63.00 days) was earlier than the earliest family (66.00 day).

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1-1.Genotypic correlation.

Days to heading (Table5) showed weak correlation with the other traits under irrigated and stressed environments except with 100-GW under drought stress which was negative (-0.34). Plant height showed weak negative correlation with NS/P (-0.21), BY/plant (-0.20) and GY/plant (-0.12) under irrigation. Otherwise, under stressed environment, PH showed positive correlation of 0.27, 0.26 and 0.24 with the respective above traits. Likewise, positive correlation of 100-GW with PH of 0.30 was found. Therefore; it was expected to increase earliness by selection with slight decrease in GY/P, 100-GW, and NG/S under normal irrigation, and vice versa under stressed environment. The results are in agreement with those of Ahmed *et al.* (2014).

Table 5. Genotypic correlation under irrigation (above diagonal) and drought (below diagonal) among traits in the F_4-generation.

Trait	DH	PH	SL	NS/P	100GW	NG/S	WG/S	BY/P	GY/P	HI
DH	-	-0.22	0.14	0.00	0.08	0.18	0.09	-0.01	0.02	0.06
PH	0.00	-	0.04	-0.21	0.06	0.05	0.07	-0.20	-0.12	0.09
SL	-0.06	0.11	-	0.07	-0.32	-0.63	-0.40	-0.37	-0.26	0.10
NS/P	0.03	0.27	0.20	-	-0.11	0.19	0.17	-0.49	-0.57	-0.21
100GW	-0.34	0.30	0.16	0.13	-	-0.23	-0.34	-0.19	-0.17	-0.01
NG/S	-0.05	0.06	0.66	0.30	-0.03	-	-0.70	-0.26	-0.26	-0.04
WG/S	-0.11	0.12	0.43	0.12	0.41	0.55	-	-0.22	-0.24	-0.07
BY/P	-0.04	0.26	0.37	0.77	0.09	0.44	0.33	-	-0.81	0.14
GY/P	-0.09	0.24	0.39	0.84	0.25	0.48	0.37	0.87	-	-0.46
HI	-0.12	-0.04	0.06	0.18	0.36	0.12	0.12	-0.20	0.29	-

2- Pedigree selection for days to heading.

Variability and heritability estimates.

All the studied traits (Table 6) of the selected families, parents and the bulk sample showed significant ($p<0.01$) after two cycles of pedigree selection for days to heading indicating the presence of variability for further cycles of selection. Similar results were observed by Ali (2012), Mahdy *et al.* (2012b), El-Ameen (2012) and Ahmed *et al.* (2014).

After two cycle of pedigree selection for days to heading (Table 6) the gcv and pcv was 6.03 and 6.15 compared to 6.42 and 6.47% in the F_4 under irrigation, and was 4.46 and 4.61 compared to 5.63 and 5.69% in the F_4-generation under drought stress; respectively. Mahdy *et al.* (2012a) observed the pcv decreased rabidly by selection for days to heading from 10.88 in F_3 to 7.99 in F_4-generation.

Close estimates of genotypic and phenotypic variability., in addition to small variance of experimental error under both environments, and evaluation of the selected families in one site for one year which inflated families mean square by the confounding effects of the interactions of the families by years and locations, all these factors resulted in very high and unreliable estimates of broad sense heritability over all traits under both environments. These results are in agreement with Mukherjee *et al.* (2008) and Mahdy *et al*. (2012b). The realized heritability of days to heading was 68.63 and 70.72 under normal irrigation and 78.73 and 66.97 under drought stress after two cycles of selection, respectively.

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Means and direct observed gain after two cycles of selection.

Mean days to heading ranged from 61.00 to 77.00 with an average of 70.17 under normal irrigation (Table 7), and from 64.33 to 75.33 with an average of 71.17 under drought stress (Table 10). These range of variability which was16 and 11 days under irrigated and stress environment; respectively, was sufficient for further cycles of selection.

The ten selected families for days to heading were significantly (p<0.01) earlier than the bulk sample under both environments. The average direct gain was significant (p<0.01) and reached -16.36 and -10.17% from the bulk sample under normal irrigation and drought stress environments; respectively. These results are in line with Ali (2011), Ali (2012) and El-Ameen (2012).

Table 7. Mean of the studied traits of the selected families for days to heading after two cycles of selection under normal irrigation.

Fam. No.	DH	PH; cm	SL; cm	NS/P	100 GW; g	NG/S	WG/ S; g	BY/ P; g	GY/ P; g	HI%
39	72.00	89.17	13.00	3.17	6.54	58.87	3.96	75.49	18.02	23.86
42	70.67	82.17	12.50	7.82	5.15	77.54	3.93	72.58	27.39	37.74
44	67.33	76.00	16.33	2.76	6.02	114.67	6.98	64.04	22.15	34.60
48	68.33	77.17	16.00	3.99	6.30	84.70	5.38	39.61	14.68	37.03
63	77.00	92.00	17.17	2.90	6.71	94.68	6.24	66.81	19.37	29.00
68	61.00	81.33	16.17	4.97	6.70	95.25	6.26	71.20	26.46	37.14
147	68.33	79.50	15.50	2.62	6.56	95.66	5.87	42.69	14.83	34.76
186	72.67	104.67	14.67	6.34	5.91	79.45	4.88	79.47	28.57	35.94
194	73.67	94.67	12.92	7.36	5.71	65.14	3.66	77.57	22.17	28.61
459	70.67	85.17	15.50	7.18	6.38	71.36	4.29	89.09	28.58	32.07
Average	70.17	86.18	14.98	4.91	6.20	83.73	5.14	67.86	22.22	33.08
bulk	83.89	95.12	13.70	4.81	5.38	76.20	4.23	72.74	16.84	23.19
Sids4	72.00	82.59	16.31	4.18	5.94	87.11	4.93	60.72	16.24	26.70
Giza168	99.17	103.84	15.69	6.65	5.11	75.60	3.87	79.23	23.27	29.38
R.L.S.D 0.05 Fam	1.99	4.27	1.29	0.95	0.41	2.79	0.58	2.68	1.85	2.19
R.L.S.D 0.01 Fam	2.65	5.67	1.72	1.26	0.54	3.71	0.76	3.57	2.46	2.91
R.L.S.D 0.05 Aver	1.48	3.16	0.95	0.71	0.30	2.07	0.43	1.99	1.37	1.63
R.L.S.D 0.01 Aver	1.96	4.21	1.27	0.94	0.40	2.75	0.57	2.65	1.83	2.16

R.L.S.D (Fam.), to compare families with the better parent and the bulk sample.
R.L.S.D (Aver.), to compare average with the better parent and the bulk sample.
***, **, significant at 0.05 and 0.01 level of probability; respectively.**

The average direct gain in percentage of the earlier parent Sids4 (Table 9) was significant (p<0.05) under normal irrigation (-2.55%), but, insignificant (-1.39%) under drought stress. On the level if individual families four families (No.44, No.48, No.68 and No.147) showed significant (p<0.01) earliness than the earlier parent Sids4 under normal irrigation. However, under drought stress two families out of ten (No.63 and No.147) (Table 12) showed significant (p<0.05) earliness from the Sids4. These results indicate that selection for earliness was more effective under normal irrigation than under drought stress in detecting the early family. Ali (2011) revealed that pedigree selection for earliness was effective in isolating early genotypes.

Correlated gains under normal irrigation after two cycles of selection.

The average correlated gains of the ten selected families (Table8) showed significant increase over the bulk sample for spike length (9.28%), grain yield/plant (31.96%), harvest index (42.64%), grain weight/spike (20.86%), number of grains/spike (9.89%) and 100-grain weight (15.13%). El-Ameen (2012) observed indirect response to selection for early families; significant positive correlated responses to selection were obtained in grain yield (12.63%). However, significant decrease (-9.40%) was recorded for plant height. Mahdy *et al.* (2012b) found that selection for heading date significantly decreased plant height, and increased significantly in grain yield/plant. Otherwise, the average correlated gain from the better parent (Table 9) showed significant increase of 12.58% for harvest index only, and significant decrease was recorded for spike length (-8.19%), biological yield/plant (-14.36%), number of spikes/plant (-26.16%) and number of grains/spike (-3.88%).

Table 8. Observed direct and correlated responses to pedigree selection for days to heading after two cycles of selection (F6) in percentage of bulk sample under normal irrigation conditions; season 2013/2014.

Fam. No.	Selection criterion	Correlated traits								
	DH	PH; cm	SL; cm	NS/P	100 GW; g	NG/S	WG/S; g	BY/P; g	GY/P; g	HI%
39	-14.17**	-6.26*	-5.14	-34.11**	21.55**	-22.74**	-6.97	3.79	7	2.9
42	-15.76**	-13.62**	-8.78	62.65**	-4.4	1.76	-7.75	-0.21	62.63**	62.75**
44	-19.74**	-20.10**	19.19**	-42.66**	11.83**	50.49**	63.98**	-11.95**	31.54**	49.21**
48	-18.54**	-18.88**	16.76**	-16.91	16.97**	11.16**	26.47**	-45.54**	-12.84*	59.71**
63	-8.21**	-3.28	25.27**	-39.72**	24.71**	24.25**	46.67**	-8.15**	15.05*	25.09**
68	-27.28**	-14.50**	17.97**	3.39	24.46**	25.01**	47.14**	-2.11	57.12**	60.16**
147	-18.54**	-16.42**	13.11*	-45.53**	21.80**	25.53**	37.82**	-41.30**	-11.94	49.90**
186	-13.38**	10.03**	7.03	31.88**	9.85*	4.26*	14.57	9.26**	69.67**	55.01**
194	-12.19**	-0.48	-5.74	53.04**	6.07	-14.52**	-14.02	6.64**	31.67**	23.40**
459	-15.76**	-10.47**	13.11*	49.35**	18.45**	-6.35**	0.7	22.48**	69.71**	38.31**
Average	-16.36**	-9.40**	9.28*	2.14	15.13**	9.89**	20.86**	-6.71**	31.96**	42.64**
L.S.D0.05Fam%	2.74	5.17	10.14	22.26	8.17	4.23	15.27	4.26	12.71	10.91
L.S.D0.01 Fam%	3.71	7.00	13.72	30.16	11.15	5.72	20.67	5.76	17.16	14.79
L.S.D0.05 Aver%	2.03	3.84	7.52	16.43	6.13	3.14	11.28	3.16	9.38	8.06
L.S.D0.01 Aver%	2.75	5.19	10.22	22.26	8.17	4.25	15.27	4.28	12.77	10.95

L.S.D (Fam.), to compare families with the better parent and the bulk sample.

L.S.D (Aver.), to compare average with the better parent and the bulk sample.

***, ** , significant at 0.05 and 0.01 level of probability; respectively.**

Based on the individual families, and depending on earliness and grain yield/plant, three superior families; No.68, No.186, and No.459 were obtained. Family No. 68 showed significant ($p<0.0$) superiority over the better parent of -

15.28, 13.71, 26.40, 26.28, 9.35 and 12.79% for days to heading, grain yield/plant, harvest index, grain weight/spike, number of grains/spike and-grain weight; respectively The superiority in grain yield of this family depended on grain weight/spike, number of grain/spike and 100-grain weight. Families No. 168 and No. 459 were comparable to Sids4 in earliness and outyielded the better parent in grain yield by 22.79 and 22.82%; respectively.

It could be noticed that families No. 44, No. 48, and No. 147 which showed significant direct gains in days to heading from the earlier parent, showed adverse effects on grain yield/plant, biological yield/plant and number of spikes/plant. Ali and Abou-El-wafa (2006), Ali (2011) found that selection for days to heading decreased grain yield/plant.

2-4. Correlated gains under drought stress after two cycles of selection.

Significant (P<0.01) average positive correlated gains for most traits were obtained and reached 17.97% for biological yield/plant, 46.94% for grain yield/plant, 25.65% for harvest index, 27.24% for number of spikes/plant, 26.81% for grain weight/spike, 22.15% for number of grains/spike and 12.29% of the bulk sample for 100-grain weight (Table11). Likewise, significant average correlated gain for biological yield/plant, grain yield/plant, harvest index, grain weight/spike, number of grains/spike and 100-grain weight of 19.26, 31.46, 11.40, 16.80, 12.65 and 8.04% of the better parent; respectively (Table 12).

One of the main goals of this study was develop high yielding early lines under irrigation and drought stress environments. Therefore, the families similar or earlier than the earlier parent Sids4 and showed significant observed gain in grain yield/plant from the better parent could be considered the best families. Families No. 63 and No. 147 showed significant direct observed gain in days to heading from the earlier parent Sids4 of -10.86 and -3.47%; respectively (Table 12). Family No.63 showed significant (p<0.01) correlated gains of 24.21 and 29.61% for biological yield/plant, 66.63 and 49.07% for grain yield/plant, 30.15 and 21.45% for harvest index, 78.26 and 64.19% for grain weight/spike, 32.82 and 22.49% for number of grains/spike and 37.41% for 100-grain weight from the bulk sample and the better parent; respectively. Family No. 147 showed significant (p<0.01) correlated gains of 21.00 and 22.32% for biological yield/plant, 31.97 and 18.66% for grain yield/plant, 83.19 and 68.73% for grain weight/spike, 38.42 and 27.65% for number of grains/spike and 28.02 and 23.17% for 100-grain weight; from the bulk sample and the better parent; respectively. It is of the interest to note that grain yield of the above two families depended on superiority of grain weight/spike, number of grains/spike and 100-grain weight, and their spike length similar to the long spike parent Sids4. Furthermore; families No. 1, No. 45, No. 62 and No. 95 were early as the earlier parent and showed significant (p<0.01) correlated gains in grain yield/plant of 31.32, 55.88, 55.88 and 38.27%; respectively from the better parent.

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Table 10. Means of the studied traits of the selected families for days to heading after two cycles of selection under drought conditions.

Fam. No.	DH	PH; cm	SL; cm	NS/P	100 GW;g	NG/S	WG/ S; g	BY/ P; g	GY/ P; g	HI%
1	70.33	77.83	13.33	4.70	4.85	90.71	2.79	56.45	20.78	36.79
45	69.67	83.17	14.00	4.90	5.33	77.08	3.60	74.08	18.98	25.63
62	71.33	103.50	14.17	6.67	5.70	71.05	3.87	62.99	24.66	39.15
63	64.33	88.67	16.00	3.73	6.64	85.05	5.75	67.23	23.58	35.18
95	70.33	81.83	14.50	6.35	4.86	62.17	3.16	59.16	21.87	37.03
147	69.67	77.83	17.17	3.39	6.18	88.63	5.91	63.45	18.68	29.46
150	71.00	83.50	13.00	5.97	5.02	58.36	2.93	50.32	16.46	33.56
186	75.33	78.50	17.67	4.71	5.60	105.53	5.83	78.69	26.09	33.18
245	75.00	88.33	15.33	5.02	4.99	76.73	3.66	50.25	18.68	37.16
459	74.67	93.83	12.83	5.78	5.07	66.86	3.39	55.97	18.19	32.53
Average	71.17	85.70	14.80	5.12	5.42	78.22	4.09	61.86	20.80	33.97
bulk	79.22	91.83	13.94	4.03	4.83	64.03	3.22	52.44	14.15	27.03
Sids4	72.17	81.72	16.39	3.23	5.02	69.43	3.07	47.18	11.64	24.66
Giza168	92.17	102.53	15.25	5.59	4.37	66.37	3.50	51.87	15.82	30.49
R.L.S.D05 Fam	1.93	5.07	1.25	0.87	0.44	3.96	0.40	5.87	1.55	4.24
R.L.S.D01 Fam	2.57	6.72	1.67	1.16	0.56	5.27	0.53	7.78	2.06	5.41
R.L.S.D05 Aver	1.43	3.76	0.93	0.64	0.32	2.94	0.30	4.35	1.15	3.14
R.L.S.D01 Aver	1.91	4.99	1.24	0.86	0.41	3.91	0.40	5.77	1.53	4.01

R.L.S.D.(Fam.), to compare families with the better parent and the bulk sample.

R.L.S.D.(Fam.), to compare average with the better parent and the bulk sample.

***.**. Significant at 0.05 and 0.01 level of probability; respectively.**

Genotypic correlations among traits after selection for days to heading

It is well known that the early plants, in other words short span life mostly affect grain yield and plant growth. Furthermore, under normal irrigation the genotypic correlation between days to heading and plant height before selection (in the F_4-generation) was negative (-0.22) meaning that long vegetative growth period, acted positively in plant height and the correlation changed from 0.22 to 0.64 after selection (Table 13). Therefore, the genotypic correlation between days to heading and biological yield changed from -0.01 to 0.27, and harvest index decreased from -0.06 to -0.61. The genotypic correlation of DH with GY/P was very weak in both of the F_4 and F_6-generations, but, changed from 0.02 to -0.09. Kilic and Yagbasanlar (2010), Bilgin *et al.* (2011) and Subhani *et al.* (2011) noted negative correlation of grain yield was observed with days to heading. Meaning that early families slight increased grain yield/plant.

Under normal irrigation in the base population (F_4) the correlation between days to heading and plant height was -0.22 and 0.14 with spike length. Therefore, selection for earliness increased the correlation with PH and BY/P and decreased it with HI and SL. Also, in the F_4 (base population) days to heading showed 0.00 and 0.02 correlations with number of spikes/plant and grain yield/plant, and positive correlations with each of 100-grain weight (0.08), number of grains/spike (0.18) and grain weight/spike (0.09). So, it is expected that early families in F_6 could show positive correlation between plant height with number of spikes/plant (0.39), grain yield/plant (0.37; in the direction of increased correlation with biological yield), negative correlations with each of grain weight (-0.14), number of grains/spike (-0.50) and grain weight/spike (-0.44). These correlations indicate that grain yield/plant of the early families will depend on number of spikes/plant.

Table11. Observed direct and correlated responses to pedigree selection for days to heading after two cycle of selection (F6) in percentage of bulk sample under drought conditions; season 2013/2014.

Fam. No.	Selection criterion	Correlated traits								
	DH	PH; cm	SL; cm	NS/ P	100 GW; g	NG/S	WG/ S; g	BY/ P; g	GY/ P; g	HI%
1	-11.22**	-15.24**	-4.33	16.83	0.41	41.67**	-13.43	7.64	46.79**	36.12**
45	-9.96**	12.71**	1.65	65.78**	18.08**	10.97**	20.18**	20.13**	74.23**	44.82**
62	-9.96**	12.71**	1.65	65.78**	18.08**	10.97**	20.18**	20.13**	74.23**	44.82**
63	-18.79**	-3.44	14.81**	-7.48	37.41**	32.82**	78.26**	28.21**	66.63**	30.15**
95	-11.22**	-10.88**	4.04	57.83**	0.62	-2.91	-1.98	12.83*	54.56**	36.99**
147	-12.06**	-15.24**	23.18**	-15.81	28.02**	38.42**	83.19**	21.00**	31.97**	8.99
150	-10.38**	-9.07**	-6.72	48.33**	3.86	-8.85*	-9.19	-4.04	16.27*	24.14**
186	-4.91**	-14.51**	26.77**	16.93	15.87**	64.80**	80.70**	50.06**	84.35**	22.74**
245	-5.33**	-3.81	10.02*	24.56*	3.24	19.83**	13.63	-4.17	32.01**	37.46**
459	-5.75**	2.18	-7.92	43.64**	5.04	4.42	5.04	6.75	28.52**	20.35*
Average	-10.17**	-6.67**	6.2	27.24**	12.29**	22.15**	26.81**	17.97**	46.94**	25.65**
L.S.D0.05 Fam %	2.81	6.20	9.69	23.35	9.73	7.14	14.27	12.55	12.58	16.20
L.S.D0.01 Fam %	3.81	8.40	13.13	31.54	13.25	9.67	19.54	17.01	17.10	21.94
L.S.D0.05 Aver %	2.08	4.60	7.18	17.14	7.25	5.29	10.55	9.31	9.33	11.99
L.S.D0.01 Aver %	2.83	6.23	9.76	23.35	9.73	7.17	14.27	12.61	12.65	16.28

L.S.D.(Fam.), to compare families with the better parent and the bulk sample.

L.S.D.(Fam.), to compare average with the better parent and the bulk sample.

***.**. Significant at 0.05 and 0.01 level of probability; respectively.**

Under drought stress the correlation between days to heading and other traits was weak except for number of spikes/plant which increased by selection from 0.03 to 0.41, 100-grain weight decreased from -0.34 to -0.63,and grain weight/spike decreased from -0.11 to -0.25.

Table 12. Observed direct and correlated responses to pedigree selection for days to heading after two cycle of selection (F6) in percentage of the better-parent under drought conditions; season 2013/2014

Fam. No.	Selection criterion	Correlated traits								
	DH	PH; cm	SL; cm	NS/ P	100 GW; g	NG/ S	WG/ S; g	BY/ P; g	GY/ P; g	HI%
1	-2.54	-24.09**	-18.65**	-15.85	-3.39	30.65**	-20.27**	8.82	31.32**	20.68**
45	-1.16	-18.89**	-13.57**	19.40*	13.61**	2.34	10.7	21.44**	55.88**	28.39**
62	-1.16	0.95	-13.57**	19.40*	13.61**	2.34	10.7	21.44**	55.88**	28.39**
63	-10.86**	-13.52**	-2.38	-33.36**	32.20**	22.49**	64.19**	29.61**	49.07**	15.38*
95	-2.54	-20.19**	-11.53**	13.68	-3.19	-10.46**	-9.71	14.06*	38.27**	21.45**
147	-3.47*	-24.09**	4.74	-39.36**	23.17**	27.65**	68.73**	22.32**	18.06**	-3.38
150	-1.62	-18.56**	-20.68**	6.84	-0.07	-15.94**	-16.35*	-2.99	4.02	10.05
186	4.38**	-23.44**	7.79	-15.78	11.49*	51.99**	66.44**	51.70**	64.92**	8.81
245	3.92*	-13.85**	-6.45	-10.28	-0.66	10.51**	4.67	-3.12	18.10**	21.87**
459	3.46*	-8.48**	-21.70**	3.45	1.06	-3.7	-3.25	7.91	14.98*	6.69
Average	-1.39	-16.41**	-9.70**	-8.36	8.04*	12.65**	16.80**	19.26**	31.46**	11.40*
L.S.D0.05 Fam %	3.09	6.96	8.24	16.82	9.36	6.58	13.14	12.69	11.25	14.37
L.S.D0.01 Fam %	4.18	9.43	11.17	22.72	12.75	8.92	18.00	17.20	15.30	19.45
L.S.D0.05 Aver %	2.29	5.16	6.10	12.34	6.97	4.88	9.71	9.41	8.34	10.63
L.S.D0.01 Aver %	3.10	7.00	8.30	16.82	9.36	6.61	13.14	12.74	11.31	14.43

L.S.D.(Fam.), to compare families with the better parent and the bulk sample.

L.S.D.(Fam.), to compare average with the better parent and the bulk sample.

***.**. Significant at 0.05 and 0.01 level of probability; respectively.**

Table 13. Genotypic correlation for selected families for days to heading under irrigation (above diagonal) and drought (below diagonal) in F_6-generation.

Trait	DH	PH	SL	NS/P	100GW	NG/S	WG/S	BY/P	GY/P	HI
DH	-	0.64	-0.29	0.12	-0.20	-0.43	-0.43	0.27	-0.09	-0.61
PH	0.06	-	-0.34	0.39	-0.14	-0.50	-0.44	0.58	0.37	-0.39
SL	-0.07	-0.39	-	-0.61	0.73	0.81	0.93	-0.39	-0.22	0.26
NS/P	0.41	0.56	-0.71	-	-0.72	-0.55	-0.74	0.63	0.75	0.20
100GW	-0.63	0.11	0.68	-0.67	-	0.23	0.54	-0.25	-0.46	-0.33
NG/S	0.03	-0.47	0.76	-0.74	0.43	-	0.97	-0.48	-0.14	0.53
WG/S	-0.25	-0.18	0.96	-0.73	0.89	0.68	-	-0.49	-0.25	0.36
BY/P	-0.19	-0.21	0.61	-0.41	0.54	0.65	0.66	-	0.81	-0.35
GY/P	-0.08	0.17	0.51	-0.04	0.41	0.54	0.49	0.65	-	0.26
HI	0.14	0.47	-0.15	0.49	-0.21	-0.16	-0.26	-0.42	0.41	-

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الانتخاب للتبكير في قمح الخبز تحت ظروف الري العادي وظروف إجهاد الجفاف

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تهدف هذه الدراسة إلى تقدير كفاءة الانتخاب لصفة عدد أيام طرد السنابل في الجيل الرابع والخامس والسادس لعشيرة قمح الخبز (جيزة ١٦٨ x سدس ٤) في بيئات الري العادي والجفاف خلال المواسم الزراعيه من ٢٠١٢/٢٠١١ الى ٢٠١٤/٢٠١٣، حيث وجد تباين عالي المعنوية في الجيل الرابع والسادس لكل الصفات تحت الدراسة بين العائلات المنتخبة لصفة عدد أيام طرد السنابل في كلا البيئتين ، وكانت قيم معامل الاختلاف المظهري ومعامل الاختلاف الوراثي منخفضة وقريبه من بعضها مما أدى إلى تقديرات عاليه لدرجة التوريث بالمعنى العام قدرت بـ ٩٨.٤٩ ، ٩٨.٠٦% وتقديرات عاليه للتقدم الوراثي المتوقع قدرت بـ ١١.٧٢ ، ١٠.٢٧% بالنسبة لمتوسط الجيل الرابع تحت ظروف الري العادي والجفاف على التوالي ، وبعد دورتين من الانتخاب المنسب لعدد أيام طرد السنابل كانت قيم معامل الاختلاف الوراثي ومعامل الاختلاف المظهري ٦.٠٣ ، ٦.١٥ مقارنة بـ ٦.٤٢ ، ٦.٤٧% في الجيل الرابع تحت الري وكانت ٤.٤٦ ، ٤.٦١ مقارنة بـ ٥.٦٣ ، ٥.٦٩% في الجيل الرابع تحت الجفاف على التوالي ، وكان متوسط التقدم المباشر لعدد أيام طرد السنابل عالى المعنوية ووصل الى -١٦.٣٦ ، -١٠.١٧% من العينة المجمعة الغير منتخبه تحت ظروف الري والجفاف على التوالي ، وكان متوسط الاستجابة المباشرة من الأب المبكر سدس ٤ معنوية تحت الري وقدرت بـ -٢.٥٥% بينما تحت الجفاف كانت غير معنوية وقدرت بـ -١.٣٩% ، وعلى مستوى العائلات الفردية في ظروف الري وجدت أربعة عائلات هى أرقام ٤٤ ، ٤٨ ، ٦٨ ، ١٤٧ أظهرت تبكير عالي المعنوية عن الأب المبكر سدس ٤ ، بينما تحت ظروف الجفاف وجدت عائلتين هما أرقام ٦٣ ، ١٤٧ أظهروا تبكير معنوي عن سدس٤ كما اظهروا تقدم مشاهد معنوي في صفة محصول الحبوب/نبات عن الأب الأفضل ويمكن اعتبارهما أفضل العائلات من العشرة عائلات المنتخبة للتبكير ، هذه النتائج توضح أن الانتخاب للتبكير كان أكثر فعاليه تحت الري العادي عن الجفاف في إظهار العائلة المبكرة ، وكان الارتباط الوراثي لعدد أيام طرد السنابل مع محصول الحبوب/نبات ضعيف جداً في كلا من الجيل الرابع والسادس لكنه تغير من ٠.٠٢ إلى ٠.٠٩ مما يعنى أن العائلات المبكرة زاد محصولها بنسبه بسيطة.