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HERITABILITY AND EARLY GENERATION SELECTION FOR DROUGHT TOLERANCE IN BREAD WHEAT

T. Y. Bayoumi

Agronomy Dept., Faculty of Agric., Suez Canal Univ., Ismailia

ABSTRACT

Early generation testing as a breeding procedure for autogamous crops consists of testing heterogeneous families followed by selection of homozygous lines from superior families. Three populations of bread wheat were derived by crossing the local variety Giza 168 to three exotic genotypes introduced from ICARDA. Giza 168 was crossed as female parent to the exotic genotypes Omtel-1, Hurani and Rusomar -9 at the experimental farm Fac. of Agric., Suez Canal Univ., Ismailia. The study was conducted to estimate heritability and responses to selection as well as relationship between grain yield and the studied traits In 2004/2005 season, 324 F_2 plants (108 plants from each population) were grown under two water regimes (stress and non stress treatments). There were significant differences among wheat populations for all the studied characters under both stress and non stress conditions. Water stress decreased all the studied characters except total root length and proline content. Among the three populations, pop. 2 (Giza 168 x Hurani) was the highest for all the studied characters. The grain yield of populations was improved markedly through indirect selection for spike length and 1000-kernel weight. Grain yield under water stress was negatively and significantly correlated to total leaf area / plant (cm^2) , heading date (days) and drought susceptibility index and positively and significantly correlated to Spike length , No. of spikes /plant and 1000-kernel weight.

Key words: ***Bread wheat, Crosses, Selection, Drought tolerance and Correlation***

INTRODUCTION

An important objective in most wheat (*Triticum aestivum* L.) breeding programs is enhancing the genetic potential for grain yield under drought conditions. Early generation selection for yield in wheat is desirable because a genotype possessing all of the desirable genes in either the homozygous or heterozygous condition occurs most often in the F_2, with its frequency declining in subsequent generations. Selection for yield potential using yield of single plants within crosses in early generations (F_2 or F_3), however, has been ineffective (Munns *et al* 2000). Because of this, many breeders and physiologists have proposed the use of morphological and/or physiological traits measured on single plants in early generations as yield potential selection criteria rather than yield itself. Grain yield in wheat can be determined by three major components: number of spikes per plant, average number of kernels per spike, and average kernel weight. When these components are measured without error and expressed in appropriate units, their product is yield. Alexander *et al* (1984), in proposing a geometric concept for yield, suggested that grain yield might be more effectively increased by selecting for one or more yield components.

One of the most important theories that have been extensively discussed in relation to breeding strategies for stress environments is whether breeding for stress environments should rely on selection under good conditions and subsequent yield testing in stress environments or on direct selection under stress conditions. Followers of the first strategy assume that varieties that give good yields in favorable conditions will also yield relatively well in unfavorable conditions. Selection in favorable conditions is easier because genetic variation and heritability are higher. This strategy also assumes that genotypes selected in stress environments will have a low yield potential in good environments. Although the argument for selection in favorable conditions has been supported by some experimental data (Cooper *et al* 1997 and Akhtar, *et al* 2001), the superior efficiency of the second strategy (direct selection under stress conditions) has been emphasized by many scientists (Ceccarelli 1987 and Bedo *et al* 2005).

The major problem with selection under stress is the variation of stress in the experimental field that makes the choice of the breeding procedures and experimental designs is of paramount importance to reduce the environmental variation and increase heritability and repeatability. Therefore, large numbers of genotypes in a single trail are often evaluated using incomplete blocks designs such as square lattices, rectangular lattices and α design.

The objectives of this study were to (i) evaluate the response of wheat genotypes to selection within and among F_2 derived families (ii) estimate heritability by parent offspring regression and heritability realized under selection and parent offspring (iii) determine the relationship between grain yield and some traits related to drought tolerance.

MATERIALS AND METHODS

This investigation was carried out at the experimental Farm, Fac. of Agric., Suez Canal Univ., Ismailia, Egypt during three successive seasons starting in 2003/2004. Three populations of bread wheat were derived 2003/2004 by crossing the local variety Giza 168 to each of three exotic genotypes introduced from ICARDA viz., Omtel-1 (Pop. 1), Hurani (Pop. 2) and Rusomar-9(Pop. 3). These genotypes were chosen based on results from a previous study by Bayoumi *et al* (2002). Omtel-1 is intermediate in height and has large spikes, kernels, low tillering potential and is of intermediate drought tolerance. Hurani and Rusomar-9 exhibit a lower degree of spike fertility, less kernel weight, with earlier heading and maturity dates and are considered drought tolerant. Name, pedigree and origin of these genotypes are illustrated in Table (1)

Table 1. Name, pedigree and origin of wheat genotypes under investigation.

No.	Name	Pedigree	Origin
1	Giza 168	MRL/BUC//SERI CM93046-8M-OY-OM-2Y-OB-OGZ	Egypt
2	Hurani	ICD-BMABL-223-ORP	ICARDA
3	Omtel -1	ICD 85 – 0988 – 6 – AP – TR – 4AROTR	Mexico/Syria
4	Rusomar-9	ICD88-1257-7AP-TR-2AP-OTR	ICARDA

In 2004/2005 season, the highest and lowest 5% F_2 plants from each population were selected for more than one character. 324 F_2 plants (108 plants from each population) with a check variety Giza 168 were grown under two water regimes. The first water regime (stress treatment) was created by withholding irrigation after emergence and giving one supplementary irrigation after 45 days from planting. The second water regime (non stress) treatment was irrigated as required during the growing seasons. The experimental plot consisted of four rows, 2 m long, row to row and plant to plant spacing were 30 and 5 cm, respectively. At maturity visual selection between F_2 families was applied independently at the two water regimes on the basis of plant height, , head size and heading date.

In 2005/2006 season, the F_3 progenies of the selected F_2 plants were planted in single row plots in randomized complete block design with three replications in rows 2 m long and spaced 30 cm apart.

Based on yield and yield components 30 families (10 families from each population) were selected for either high trait expression in each water regime.

The following characters were measured for F_2 and F_3 families:

1-Total leaf area/plant (cm^2)

2- Total root length (cm) ; which measured by Auger sample and measured using the intersection method of Newman (1966), further modified by Tennant (1975) from the following formula

$R = 1.57 \times N$ Where;

R = total root length in centimeters

1.57= length conversion factor depends on the grid unit using in counting (grid units is likely related to crop which its root is to be measured, here in wheat crop this factor is 1.57). N= Number of intersections counted

3-Root length to leaf area ratio (R: L)

The length of roots required to supply water and nutrients to each cm^2 leaf area was calculated by dividing root length (cm) / leaf area (cm^2). This parameter can be called "allometry term" where the allometric relationship computed for measurements which need to be confined either to those two components such as length and area.

4-Plant height (cm) 5-Spike length (cm)

6-Number of spikes/plant 7- 1000-kernel weight (g)

8-Grain yield/plant (g) 9- Drought susceptibility index (S)

Fischer and Maurer, 1978 provides a measure of stress resistance based on minimization of yield loss under stress as compared to optimum conditions. It was used to characterize relative stress tolerance of all genotypes in a population from the following formula

$$S = \frac{1 - Y_d / Y_p}{D}$$ Where:

Y_d = mean grain yield in stress environment

Y_p = mean grain yield in stress environment

D=Environment stress intensity=1-(mean Y_d of all genotypes / mean Y_p of all genotypes)

10- Proline determination

Proline was determined in fully expanded leaves according to Pesci and Beffagna (1984). 50 mg fresh weight samples were extracted with 10 ml of sulphosalicylic acid solution for 1 hour at room temperature and filtered on whatman fiber glass paper. A part of extract was added to 4 ml ninhydrin reactive and 4 ml of acetic and incubated in boiling water for 1 hour. After fast cooling in ice, the samples were added to 5 ml of toluene and strongly shaken. The toluene phase, containing the colored complex was used to measure the absorbance at 515 nm versus toluene. Absorbance values were used to calculate the proline amount in each sample by using of a calibration curve, made from known amounts of proline.

Statistical analysis

The experimental design was an 18 x 18 simple lattice for each water regime in F_2 generation .Yield and yield attributes of the selected F_2's plants were analyzed using incomplete block design.. While, the F_3 progenies of the selected F_2 plants (10 families from each population) were analyzed using RCBD according to Steel *et al* (1997). A computer program Genstat 8 Rel.PL16 was used for analyzing data. Analysis of variance of data from each cross in each individual water regime was performed for all trials and all effects were considered random.

Narrow sense heritability

Narrow sense heritability (h^2) was estimated from parent offspring regression of selected families in the F_2 and F_3 generations according to Anderson *et al* (1991) using the following model

$$Y_i = a \div b_{xi} + e_i$$

Where . Y_i = mean measurement of offspring (F_3) from the ith family, X_i= mean measurement of offspring (F_2) from the ith family, and e_i = error.

The regression coefficient (b) is thus

$$b = \frac{\Sigma_I (x_i - x^{\cdot})(y_i - y^{\cdot})}{\Sigma_I (x_i - x^{\cdot})^2} = \frac{\sigma_{xy}}{\sigma^2_x}$$

Where σ_{xy} = covariance of parent – offspring and σ^2_x = total variance of parental measurements (σ^2_{ph})

Realized heritability

Realized heritability was computed according to Alexander *et al.,* (1984) from the following formula:

$$h^2 = (h^{\cdot}_{Ft+1} - L^{\cdot}_{Ft+1}) / (h^{\cdot}_{Ft} - L^{\cdot}_{Ft})$$

Where; $h^{\cdot}$ and $L^{\cdot}$ refer to the mean values of the high and low F_2 plants and F_3 progenies means for a specific character. The subscripts F_t and F_{t+1} denote the generation in which selection occurred and the subsequent generation in which the response was measure, respectively.

Response to selection:

The genetic gain for small grains (Gs) to be expected from selection of the top 5% of lines after one cycle of selection was calculated to the formula

$$G_s = h^2\, k\, \delta_p$$

RESULTS AND DISCUSSION

Mean performance

The analysis of variance indicated significant differences among F_2 wheat populations for all the studied characters under both stress and non stress conditions. Water stress deceased all the studied characters except total root length and proline content. Among the three populations, pop. 2 (Giza 168 x Hurani) was the highest for all the studied characters and pop. 3(Giza 168 x Rusomar-9) was the lowest, while pop. 1 (Giza 168 x Omtel - 1)was intermediate under both conditions (Table 2). The higher grain yield of pop. 2 under drought stress was associated with greater proline accumulation and increased root length / leaf area ratio. The latter ratio may express the tendency to maintain plant nutritional balance necessary for high yield under stress conditions.

Leaf growth is generally more sensitive than root growth to water stress. Reduced leaf expansion is beneficial to plants under water deficit condition, as less leaf area is exposed resulting in reduced transpiration. Wheat plants in pop. 2 reduced leaf area (24.9 cm^2) comparing with 29.5 cm^2 for pop.1 and 36.7 cm^2 for pop.3 by accelerating senescence and abscission of the older leaves, this process is known as leaf area adjustment. There were significant difference under stress condition among selected wheat plants in root length required to supply one cm^2 leaf area (R: L) with water and nutrient. The wheat plants under stress condition produced more roots to supply water and nutrients to the leaf area than non stress. Population 2 showed the highest R: L values, 2.24 and 8.15 under non stress and stress conditions, respectively. Araus (2002) suggested that root /leaf area ratios under water stress tended to increase about five times as under non stress. This usually arises from a greater decrease in leaf area and increase in total root length as attempt from plants to maintain the nutritional balance necessary for high possible yield under stress conditions. Root characteristics such as depth and abundance are known to be associated with performance under drought in many studied with wheat.

Proline was strongly up regulated by water stress, the proline content increased about ten times in wheat plants where, it was increased from 1.93 under non stress to 19.6 mg/g under stress condition. It is indicating that accumulated proline acts as a compatible solute regulating and reducing water loss from the cell during episodes of water deficit (Tester and Bacic ,2005).

Almost all biochemical and physiological processes in plants are relevant to physiological component of yield. These processes which associated with crop growth and development are influenced by water deficits. Water stress reduced grain yield and its component and there were significant differences among wheat populations. Population 2 showed the highest grain yield /plant, where, it ranged from 16.5 to 29.4 g and 10.1 to 19.2 g under non stress and stress, respectively (Table 2).

A drought susceptibility index (S) was used as a parameter to provide a measure of stress tolerance based on minimization of yield loss under stress as compared to optimum conditions. Low drought susceptibility index ($S < 1$) is synonymous with higher stress tolerance. Population 2 and pop.3 had a greater number of lines with Lower drought susceptibility index ($S < 1$), The larger values of S indicate greater drought susceptibility, therefore, the parent Giza 168 was more susceptible to water stress (Fig. 1).Families which may be identified as stress tolerant using S index should possess tolerance mechanisms, and may need to be incorporated into germplasm with higher yield potential.

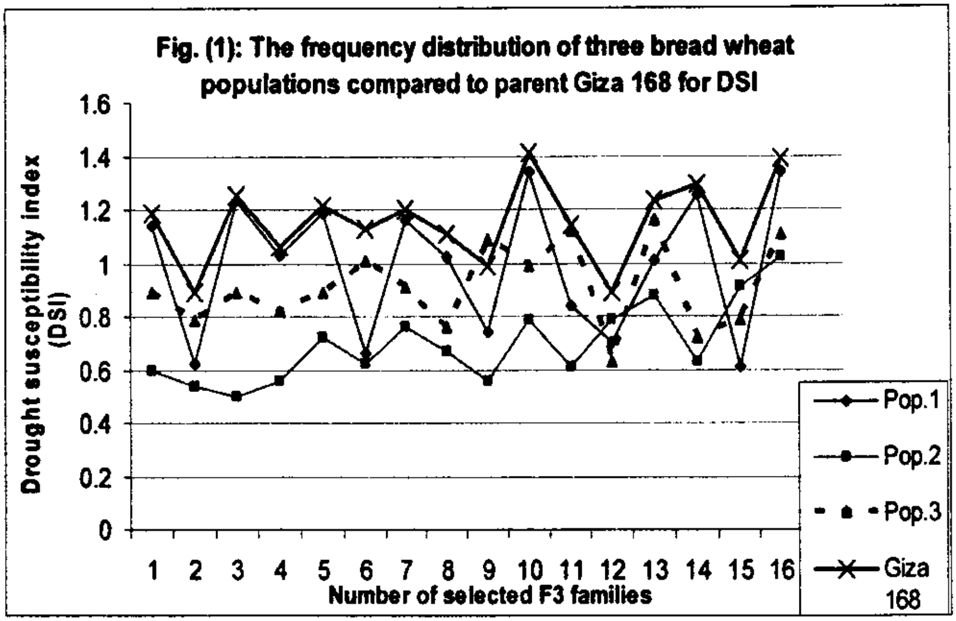
Heritability estimates

Realized heritabilities for grain yield and its attributes are shown in Table (3). In all populations heritabilities which estimated by F_2 and response in F_3 generations were high for the most traits but they were low for total leaf area and the (R:L). Under non stress they ranged from 0.24 to 1.75 for (pop. 1), 0.12 to 1.95 for (pop. 2) and 0.40 to 1.63 (pop. 3), while they ranged from 0.36 to 1.66 (pop. 1), 0.47 to 1.71 (pop. 2) and 0.52 to 1.83 (pop. 3) under stress condition. It is noticed that realized heritability was not constant under both stress and non stress for the same trait. Generally, these realized heritabilities showed that selection for root length, heading date, spike length, no. of spikes / plant, 1000- kernel weight, proline content under stress condition and drought susceptibility index were effective in both F_2 and F_3 generations under stress and non stress conditions. According to these results, it can be concluded that selection for drought tolerance in early generation may be successful under both stress and non stress conditions.

Linear regression for offspring to trait mean was used to determine and assess the heritability in traits and responses to direct selection for grain yield. Heritability estimates decreased under stress conditions than non stress conditions (Table 4). R:L was the lowest trait in narrow sense heritability for all populations under both water regime . The spike length was the highest in heritability and gave (0.911 and 0.867),(0.926 and 0.867)

Table 2. Mean and range of traits of wheat populations under non stress and stress conditions.

Character	Pop.(1) Giza 168 x Omtel-1				Pop.(2) Giza 168 x Hurani				Pop.(1) Giza 168 x Rusomar-9			
	Non stress		Stress		Non stress		Stress		Non stress		Stress	
	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range
Total leaf area / plant(cm^2)	55.9	39.7-66.8	29.5	19.7-33.9	56.5	31.9-61.2	24.9	21.7-34.1	50.1	39.4-60.9	36.7	22.8-50.6
SE±	3.11	**	3.24	**	3.49	**	4.21	**	2.98	**	4.18	**
Total root length (cm)	100.1	44-150.1	153.8	70.2-230	126.8	80.2-166	203.1	87.8-311	72.9	48.8-97	137.9	72.7-203.
SE±	29.97	Ns	11.58	**	19.87	*	12.82	**	40.35	Ns	12.33	**
Root length/leaf area	1.79	1.1-2.24	5.21	3.56-6.7	2.24	2.51-2.71	8.15	4.04-9.12	1.45	1.23-1.59	3.75	3.18-4.45
SE±	0.65	Ns	0.14	**	5.87	Ns	1.8	**	4.4	Ns	1.0	**
Heading date (days)	94.5	92-97	84.7	81-88	94.1	87-99	89	85-93	93	88-98	88	85-91
SE±	0.003	**	1.06	**	0.06	**	1.09	**	0.11	**	0.89	**
Plant height(cm)	85.5	77-92	72.5	62-83	87.6	80-94	76.2	64-88	94.5	92-97	75.5	72-79
SE±	0.316	**	0.817	**	0.258	**	0.697	**	0.994	**	1.213	**
Spike length (cm)	8.5	7.4-9.3	6.9	6.2-7.7	11.8	9.5-13.2	7.4	4.5-8.3	8.1	6.7-9.4	6.5	5.5-7.5
SE±	0.075	**	0.069	**	0.097	**	0.115	**	0.208	**	0.267	**
No. of spikes /plant	3.1	2.1-4.0	1.8	1.2-2.5	3.7	2.8-4.6	2.6	1.1-4.0	3.2	2.3-4.2	1.8	1.1-2.5
SE±	0.03	**	0.13	**	0.061	**	0.105	**	0.08	**	0.187	**
1000-kernel weight	34.9	31.3-39.6	27.8	22.9-32.8	38.3	31.6-45.1	35.1	27.6-36.5	31.6	27.1-36.1	24.7	18.8-30.6
SE±	2.043	**	3.14	**	0.731	**	1.892	**	1.096	**	0.956	**
Proline content (mg/g)	1.85	1.1-2.6	16.4	4.4-26.3	1.93	1.9-2.9	19.6	6.8-31.4	1.55	1.3-1.8	16.8	5.3-28.3
SE±	1.84	Ns	0.143	**	2.19	Ns	0.097	**	3.11	Ns	0.154	**
Grain Yield/ plant (g)	20.8	14.2-27.4	13.9	9.2-18.5	23.6	16.5-29.4	14.7	10.1-19.2	21.6	15.8-27.5	14.4	9.8-19.1
SE±	1.04	**	1.10	**	1.38	**	1.52	**	2.05	**	2.17	**



and (0.901 and 0.812) for pop. 1,2 and 3 under non stress and stress conditions ,respectively Grain yield showed lower narrow sense heritability than realized heritability under both water regimes

To achieve genetic improvement through selection, heritability must be reasonably high. The high heritability of yield components (spike length, No. of spikes/plant and 1000- kernel weight) indicates that good gain from selection can be expected and these traits can be effectively selected in early generation. R:L and grain yield / plant were low under both water regime , indicating the presence of high genotype x environment interaction between these traits. The ideal trait to be used as an additional or alternative selection criterion to yield in breeding for drought tolerance should satisfy the following requirements; (1) be causally related or genetically linked to yield under stress condition; (2) exhibit genetic variation; (3) be highly heritable; (4) be easy, inexpensive and quick to screen (Bedo *et al* 2005).

Table 3. Realized heritabilities for yield and yield attributes under non stress and stress conditions.

Character	Pop.(1) Giza 168 x Omtel-1				Pop.(2) Giza 168 x Hurani				Pop.(1) Giza 168 x Rusomar-9			
	Non stress		Stress		Non stress		Stress		Non stress		Stress	
	h^2	G_s	h^2	G_s	h^2	G_s	h^2	G_s	h^2	G_s	h^2	G_s
Total leaf area / plant	1.17	5.54	0.41	1.94	1.35	10.6	0.48	8.94	1.38	9.45	0.52	3.98
Total root length (cm)	0.94	6.97	1.01	17.89	0.96	21.5	1.03	23.8	1.04	21.6	1.90	13.6
Root length/leaf area	0.38	3.03	0.36	2.87	0.12	4.78	0.47	2.69	0.40	5.67	0.52	3.11
Heading date (days)	0.81	42.22	1.57	93.46	0.75	15.8	1.71	25.8	0.70	11.8	1.83	19.6
Plant height (cm)	0.93	17.43	0.51	9.56	1.01	20.5	0.53	12.3	1.35	22.4	0.60	10.6
Spike length (cm)	1.75	53.35	0.62	18.90	1.95	34.6	0.66	14.8	1.29	28.7	0.72	12.9
No. of spikes /plant	1.35	12.68	1.66	15.59	1.81	13.8	0.90	9.8	1.63	15.4	0.98	9.13
1000- kernel weight	0.94	33.11	0.95	29.55	0.99	34.2	0.93	28.3	0.98	20.8	0.93	16.2
Proline content (mg/g)	0.24	1.13	1.16	5.49	0.39	3.6	1.02	10.5	0.45	2.76	1.21	6.51
Grain Yield/ plant (g)	0.94	37.95	0.55	9.61	0.76	20.5	0.59	3.7	1.16	38.8	0.65	1.6
Drought susceptibility index	-	-	1.12	22.61	-	-	1.08	20.3	-	-	1.23	15.6

Effects of selection

The effectiveness of selection for grain yield under stress and non stress environments varied from population to population. The gains in yield for each selection cycle based on realized heritabilities under stress condition (Table 4), represented 9.61, 3.7 and 1.6% for populations 1, 2 and 3, respectively

The gains in yield for selection based on narrow sense heritabilities were 10.88, 4.83 and 1.43 % for populations 1, 2 and 3, respectively. The grain yield of populations were improved markedly through indirect selection for spike length and 1000-kernel weight The selection gain for grain yield indicated that the heritability estimates was sufficient to encourage selection in early generations when lines were grown under stress condition. These results are in agreement with Novoselovic *et al* (2004).

Table 4. Narrow sense heritabilities determined by regression for offspring's and response to selection for yield and yield attributes under non stress and stress conditions.

Character	Pop.(1) Giza 168 x Omtel-1				Pop.(2) Giza 168 x Hurani				Pop.(1) Giza 168 x Rusomar-9			
	Non stress		Stress		Non stress		Stress		Non stress		Stress	
	h^2	G_s	h^2	G_s	h^2	G_s	h^2	G_s	h^2	G_s	h^2	G_s
Total leaf area / plant	0.446	2.11	0.395	2.43	0.484	7.57	0.413	6.46	0.422	10.86	0.351	9.03
Total root length (cm)	0.761	5.87	0.782	15.62	0.793	7.84	0.754	7.45	0.715	22.07	0.646	19.94
Root length/leaf area (%)	0.297	2.37	0.248	1.98	0.339	3.56	0.308	3.23	0.347	2.22	0.316	2.02
Heading date (days)	0.845	58.83	0.814	50.67	0.873	28.77	0.832	21.42	0.781	18.01	0.759	17.51
Plant height (cm)	0.632	14.04	0.598	13.30	0.764	2.04	0.657	5.56	0.676	1.40	0.615	1.27
Spike length (cm)	0.911	28.52	0.867	19.62	0.926	22.82	0.867	11.96	0.901	20.43	0.812	18.7
No. of spikes /plant	0.841	9.81	0.785	9.21	0.852	17.55	0.801	16.50	0.783	14.53	0.726	13.47
1000- kernel weight	0.756	27.87	0.713	28.74	0.829	34.66	0.788	32.95	0.689	15.62	0.614	16.45
Proline content (mg/g)	0.802	3.79	0.783	19.33	0.864	1.67	0.813	21.12	0.783	1.29	0.712	1.48
Grain Yield/ plant (g)	0.561	19.75	0.412	10.88	0.483	9.10	0.442	4.83	0.498	7.19	0.416	1.43
Drought susceptibility index	-	-	0.779	18.9	-	-	0.887	27.22	-	-	0.728	10.51

Relationship among traits

Phenotypic correlation between grain yield and the studied traits was calculated to find out whether character can be used as indicator for grain yield under stress and non stress conditions Table (5). Grain yield correlated with total leaf area / plant (cm^2) , heading date (days) and drought susceptibility index in a significant negative way under water stress and positively under non stress. Spike length (cm) , No. of spikes /plant and 1000- kernel weight correlated positively and significantly under both water regimes.. These results indicated that the reduction of total leaf area is an important adaptive mechanism under drought stress. Moreover, families which flowered earlier tended to give higher yield than later flowering families. Proline accumulation in plants under drought conditions appears to be associated with the ability to withstand the effects of water stress

Table 5. Phenotypic correlation between grain yield and the studied characters for the wheat families under stress and non stress conditions.

Character	Non stress		Stress	
Total leaf area / plant (cm^2)	0.752	**	-0.635	**
Total root length (cm)	0.189	ns	0.801	**
Root length/leaf area (%)	0.131	ns	0.485	*
Heading date (days)	0.648	**	-0.655	**
Plant height (cm)	0.132	ns	0.109	ns
Spike length (cm)	0.761	**	0.773	**
No. of spikes /plant	0.687	**	0.411	*
1000- kernel weight	0.822	**	0.856	**
Proline content (mg/g)	0.133	ns	0.887	**
Drought susceptibility index		-	-0.859	**

ns,* and ** represent non significant and significant at P 0.05 and 0.01 , respectively,

The highest yield for the best F_3 families and their corresponding selection traits are shown in Table (6). This is direct measure of the effectiveness of indirect selection for grain yield via its components and of direct selection for yield itself in this early segregating generation. Selection for decreasing number of days to 50% heading may have been favored by partial escape from drought in F_3 generation was identified in Giza 168 population. The best yielding lines in F_3 of pop.2 were accompanied by higher values for the three yield components spike length, No. of spikes / plant and 1000- kernel weight under non stress. The superiority lines in pop.2 under water stress may be due to balance of shoot / root ratio, more accumulation of proline which acts as a control mechanism for draught tolerance.

Trasgressive segregation occurs when the range of performance of genotypes in a segregating population are extremes beyond the range of parental values. It arises from contribution of complementary genes from both parents, and is exploited to select individuals superior to the parents (Ibrahim and Quick 2001).

Table 6. Means of grain yield and other characters of the best selected families in F_3 under non stress and stress conditions

Traits	Leaf area		Root length		R:L		Heading date		Spike length		No. of spikes		1000-KW		Proline content		Grain yield		DSI
	N.S	S	N.S	S	N.S	S	N.S	S	N.S	S	N.S	S	N.S	S	N.S	S	N.S	S	S
Population 1 (Giza 168 x Omtel-1)																			
1	44.0	26.1	297	652.4	6.7	24.9	93	81	11.03	7.7	5.5	2.1	49.6	36.7	3.67	28.3	27.4	9.75	0.61
2	40.3	18.42	295	635.8	7.32	34.5	94	93	11.52	7.2	5.3	1.0	41.8	32.8	3.56	27.4	27.1	13.7	0.62
3	39.5	16.64	235	658.0	5.94	39.5	94	84	12.32	7.4	4.0	2.0	41.4	29.3	3.32	25.6	24.6	13.55	0.66
4	38.3	17.46	233	644.0	6.8	36.8	97	91	11.84	7.5	3.0	1.8	42.4	26.3	3.15	24.3	24.1	12.05	0.70
5	37	20.34	230	603.0	6.21	29.6	94	88	11.2	7.3	6.0	1.6	39.7	30.3	2.89	22.3	22.8	12.3	0.74
6	33.9	22.2	227.1	831.6	6.69	37.4	95	85	12.0	8.3	2.7	1.4	37.5	31.3	2.83	21.8	21.3	11.4	0.84
7	30.7	17.4	221	826	7.19	47.4	92	87	13.92	7.4	4.8	2.5	36.9	24.6	2.45	18.9	23.5	10.65	0.99
8	29.1	23.7	215.7	618.8	7.41	26.1	94	90	14.04	7.0	3.0	1.5	36.8	22.9	2.10	16.2	22.3	10.15	1.01
9	29	26.4	202	603.9	6.96	22.8	96	90	14.4	8.8	4.2	1.9	36.9	35.5	1.98	15.3	24.1	10.05	1.02
10	28.2	24.18	198.6	565.6	7.04	23.3	95	89	11.2	9.0	3.2	1.3	37.3	34	1.45	11.9	23.8	9.9	1.14
Mean	35.0	21.2	235.4	663.9	6.72	31.3	94.	87.	12.3	7.7	4.1	1.7	40.0	30.3	2.7	21.2	24.1	11.3	0.83
Population 2 (Giza 168 x Hurani)																			
1	43.7	16.44	314	871	7.18	52.9	94	81	13.28	8.3	6.5	2.3	49.9	36.5	3.86	31.4	30.5	14.65	0.91
2	32.4	16.86	311.1	879.2	9.60	52.1	97	90	12.56	7.8	6.9	2.2	44.6	27.1	3.84	29.7	29.4	15.25	0.54
3	32	14.04	158.2	442.9	4.94	31.5	92	85	11.52	7.7	4.2	3.1	46.2	30.8	3.80	29.6	29.3	14.1	0.62
4	31.6	19.44	156.3	437.6	4.96	22.5	97	91	11.45	8.5	4.6	3.7	48.3	30.5	3.56	29.3	28.2	14.7	0.52
5	30.1	19.2	139	387.5	4.61	20.1	93	81	12.32	7.3	6.2	3.6	42.2	37	3.15	27.4	27.4	12.8	0.61
6	28.1	26.22	138.4	377.7	4.92	14.4	96	88	13.6	7.4	4.7	3.1	42.16	25.5	3.47	26.7	25.8	12.65	0.88
7	27.4	16.36	137	389.2	5.0	23.7	95	85	11.84	7.1	5.0	2.8	42.3	27.2	2.54	28.3	25.6	12.6	0.67
8	27.4	18.1	134.9	383.6	4.92	21.1	96	88	14.26	6.6	4.1	3.2	41.2	31.1	3.60	26.6	25.3	13.7	0.56
9	27.1	18.95	96.4	269.9	3.55	14.2	99	96	14.51	6.9	3.8	1.6	39.8	29.2	3.67	24.4	25.2	12.9	0.60
10	26.5	15.9	83.5	233.8	3.15	14.7	95	90	11.4	6.7	3.0	1.4	39.4	31	3.49	25.9	25.2	12.6	0.76
Mean	30.6	18.15	166.8	467.2	5.45	25.7	95	87	12.6	7.4	4.6	2.5	43.6	30.5	3.5	27.9	27.1	13.5	0.66

Table (6) cont.

Population 3 (Giza 168 x Rusomar-9)																			
1	51.6	20.64	204.6	572	3.96	27.7	92	85	11.8	6.2	4.8	2.1	41.6	30.6	3.39	24.2	26.5	10.95	0.79
2	39.2	18.24	203.1	568.6	5.18	31.1	87	87	1056	7.5	3.0	1.1	41.2	30	3,27	23.4	26.5	13.25	1.01
3	35	30,96	196.4	549.9	5.61	17.7	99	88	12.0	6.1	2.6	1.8	41.4	28.5	3.14	22.6	26.2	10.1	0.63
4	34.4	16,68	135	378	3.92	22.6	96	91	9.92	6.2	2.3	1.5	41.0	21.5	3.04	25.2	23.6	13.1	0.72
5	33.5	17,28	131.1	367	3.91	21.2	95	90	9.79	6.6	2.7	1.8	49.0	30.3	2.93	26.1	23.1	10.35	0.76
6	32	19.2	124.6	348.8	3.89	18.1	93	85	10.5	7.4	2.4	1.0	38.7	30.5	2.18	16.79	22.8	13.25	0.82
7	30.4	23.5	119.8	335.4	3.94	14.2	88	87	11.8	6.5	3.0	2.0	35.7	30.2	1.97	15.2	21.9	11.55	0.89
8	30.2	16.38	113.5	317.8	3.75	19.4	97	92	9.12	6.0	2.6	1.5	33.0	28.9	1.88	19.1	21.7	11.4	0.72
9	29.6	17.76	109.7	307.1	3.70	17.2	93	87	9.92	5.7	3.0	1.2	39.3	36.1	1.84	19.4	20.8	10.25	0.89
10	28.8	18.12	109.2	305.7	3.79	16.8	93	88	9.76	5.5	4.2	2.0	33.0	28.2	1.40	18.4	20.7	9.8	0.99
Mean	34.4	19.8	144.7	405.0	4.20	20.4	93.	88.	11.5	6.3	3.0	1.6	39.4	29.4	2.5	21.0	23.3	11.4	0.82
Local variety Giza 168																			
Mean	28.6	16.5	51.2	75.9	1.79	4.60	92	89	9.1	5.8	3.5	1.1	35.2	24.3	1.61	9.87	21.3	8.1	1.24
LSD 5%	1.25	3.75	5.6	10.2	0.09	0.14	1.5	1.9	1.7	1.1	0.82	0.3	2.6	3.3	1.12	2.78	3.8	2.8	0.13

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كفاءة التوريث و الانتخاب في الأجيال المبكرة للتحمل للجفاف في قمح الخبز

طارق يوسف بيومي

قسم المحاصيل – كلية الزراعة – جامعة قناة السويس– الإسماعيلية

تستخدم طريقة الانتخاب فى الأجيال المبكرة كطريقة من طرق تربية المحاصيل ذاتية التلقيح لاختبار العائلات الخليطة متبوعا بالانتخاب للسلالات المتماثلة من العائلات المتفوقة. كونت ثلاث عشائر من قمح الخبز عن طريق تهجين الصنف جيزة ١٦٨ (كأم) مع ثلاث تراكيب وراثية مستوردة من الايكاردا (كآباء) وهم Omtel-1 , Hurani و Rusomar -9 بمزرعة كلية الزراعة جامعة قناة السويس بالاسماعلية.

أجريت هذه الدراسة لتقدير كفاءة التوريث و الاستجابة للانتخاب و دراسة العلاقة بين المحصول و باقي الصفات المدروسة خلال ثلاث مواسم متتالية ابتداء من موسم ٢٠٠٣/٢٠٠٤ ، حيث تم زراعة ٣٢٤ نبات من نباتات الجيل الثاني (١٠٨ نبات من كل عشيرة) تحت معاملتين من الري، ري عادى و إجهاد مائي (حيث منع الري بعد ظهور البادرات فوق سطح التربة حتى الحصاد مع إعطاء ريه تكميلية بعد ٦٠ يوم من الزراعة). أوضحت النتائج أن هناك اختلافات معنوية بين العشائر في الصفات المدروسة تحت كل من معاملتي الري. خفض الإجهاد المائي كل الصفات المدروسة عدا طول الجذر و محتوى الأوراق من البرولين. كانت العشيرة رقم ٢ (Giza 168 x Hurani) هي الأعلى فى جميع الصفات المدروسة.

أمكن تحسين محصول الحبوب لعائلات الجيل الثالث عن طريق الانتخاب الغير مباشر لطول السنبلة و وزن ١٠٠٠ حبة. ارتبط محصول الحبوب ارتباطا سالب و معنويا مع مساحة الأوراق للنبات و دليل الحساسية للجفاف ، بينما ارتبط ارتباطا موجبا و معنويا مع طول السنبلة و عدد السنابل للنبات و وزن ١٠٠٠ حبة.

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