J. Agric. Sci. Mansoura Univ., 29 (11): 6213 - 6224, 2004

NATURE OF GENE ACTION FOR EARLINESS AND YIELD IN BREAD WHEAT UNDER HEAT STRESS.

El-Sherbeny, G.A.R.
Dept. of Agric. Botany (Genetics), Sohag Fac. of Agric., South Valley Univ., Egypt

ABSTRACT

Five Egyptian and exotic wheat cultivars and their all half diallel possible cross combinations were used to generate combining ability information and identify suitable parents and cross combinations for further exploitation under normal (D_1) and late (D_2) planting dates. Mean squares of genotype x environment interactions were highly significant, suggesting a differential response of the genotypes under normal and stress environments. Heat stress conditions caused reduction about 7.69%, 5.84% and 19.37% in the F_1 hybrids average for heading date, 1000 grain weight and grain yield per plant, res

pectively. The results also revealed that all cross combinations including Dovin-2 (P_3), Giza 164 (P_4) and two out of four crosses including Sakha 69 (P_1) gave susceptibility index (S) values less than the unity. This result that indicated that they transmitted their genes controlling heat tolerance. It was also noticed that the two crosses (P_1xP_3) and (P_1xP_4) gave the highest yield under both the two environments with susceptibility index less than unity. Correlation coefficients between stress susceptibility index (S) and each of grain yield per plant and heading date were -0.34 and 0.84, respectively. Estimates of general combining ability of each parent revealed that the parents Sakha 69 (P_1), Giza 164 (P_4) and Dovin-2 (P_3) possessed more desirable additive genes for all studied traits under each of the two environments and their combined data. whereas, Gemmeiza 5 (P_2) and Bau`S` (P_5) were the poorest general combiners for the same traits. The results indicated that the cross combination (P_1xP_3) exhibited significant SCA effects for earliness and high yielding ability under normal and stress conditions. While, the two crosses (P_2xP_4) and (P_3xP_5) revealed significant SCA effects for grain yield per plant and 1000 grain weight, respectively, under each of the two environments and their combined data. The results also indicated that the non additive gene action including dominance (σ^2_D) played a major role in the inheritance of days to heading. On the other hand, the estimates of additive variance (σ^2_A) were higher than those of non additive ones (σ^2_D) for 1000 grain weight and grain yield per plant at optimum and stress conditions as well as their combined data, verifying by the ratios $(\sigma^2_D/\sigma^2_A)^{1/2}$ which were less than unity. The interaction σ^2_AxE variance was positive and lower than those of σ^2_DxE ones for heading date, verifying by the ratios $(\sigma^2_DxE/\sigma^2_AxE)^{1/2}$ which were more than unity. In contrast, the ratio $(\sigma^2_DxE/\sigma^2_AxE\ )^{1/2}$ were less than unity for 1000 grain weight and grain yield per plant. This finding indicated that the additive gene effects were more influenced by heat stress than non additive ones. The results showed that the largest values of broad sense heritability were observed for heading date (87.22% and 93.26%) under normal and stress conditions, respectively. While, the largest estimates of narrow sense heritability were obtained for 1000 grain weight (44.46% and 49.93%) and grain yield per plant (55.84% and 62.00%) under normal and stress conditions, respectively. Estimates of nature of gene action and narrow sense heritability in these promising populations proved that selection for heat tolerance could be effective in early segregating generations.

INTRODUCTION

Modern wheat cultivars are well adapted to control cultural practices, but they are generally not highly tolerant to extreme environmental stresses, such as high temperature. The varieties of one region are generally not suitable for the others, and separate breeding objectives will be needed for each situation (Rajaram 1988).

In Upper Egypt, heat stress is considered one of the most environmental problems limiting wheat production. Since plant tolerance to temperature stress is heritable, selection and breeding could be used to improve this trait. Hence, development of heat tolerant cultivars in wheat is an important aim for wheat breeders in this area. In this respect, selection of resistant genotypes to heat is very related to its genetic ability to maintain the duration of growth periods (Shpiler and Blum, 1986). Higher grain yield particularly under high temperature of late sown conditions, indicates presence of genes for heat tolerance (Sharma *et al* 2002).

Thus, information on gene action and genetic system controlling heat resistant provides the basis for identifying desirable parents and crosses which may give useful segregants for this trait. Combining ability analysis provides a guideline for selection parental cultivars and their desirable cross combinations under different environmental conditions. Additive and non additive gene variances were found to be controlled the expression of days to heading, 1000 grain weight and grain yield per plant under two planting dates (Bakheit *et al*, 1989; Kheiralla and Sherif, 1992; Sharma and Tandon, 1997 and Joshi *et al* , 2002). However, Dhanda and Sethi (1996) reported that additive gene effects appeared to be the important factor contributing to the genetic control of days to heading, 1000 grain weight and grain yield per plant under both environments.

Kheiralla and Sherif (1992) stated that narrow sense heritability estimates were relatively high for both 1000 grain weight and days to heading, and moderate for grain yield per plant under normal and stress planting date conditions. While, El-Sherbeny (1999) obtained moderate narrow sense heritability values for days to heading and grain yield per plant under both environments.

Therefore, genetic improvement of wheat requires exploitation of genetic variation for heat resistance and its utilization in breeding programs. The present investigation was undertaken to study the nature of genetic system controlling earliness, 1000 grain weight and grain yield per plant under normal and stress planting dates conditions. It was also aimed to identify genotypes that will be high in yielding ability under heat stress.

MATERIALS AND METHODS

The present investigation was carried out at the Experimental Research Farm of Sohag Faculty of Agriculture, South Valley University. In this study, five bread wheat cultivars (*Triticum aestivum L.*) representing a wide range of diversity were chosen as parents. Three of them are local cultivars [Sakha 69 (P_1), Gemmeiza 5 (P_2) and Giza 164 (P_4)]. While, the others are exotic [Dovin-2 (P_3) and Bau`S` (P_5)].

In 2002/2003 growing season, the five parents were crossed according to crosses diallel mating design in all possible combinations excluding reciprocals to produce ten F_1 hybrids. All parental genotypes were also self of pollinated to increase seeds from each one.

In the growing season 2003/2004, seeds of the five parents and their 10 F_1 hybrids were grown in two planting dates. The first date was 15 of November (favourable planting time), while the second date was 15 of December (late planting date).

At each date, the parents and their 10 F_1 hybrids were sown in a randomized complete blocks design with three replications. Each replicate contained 15 plots. Each plot consisted of one row with 3 m. long and 20 cm. apart between rows. Plants were spaced by 10 cm. within row. All recommended cultural practices were applied in the two environments. Average of the monthly degrees of temperature (minimum and maximum) in the growing season of 2003/2004 at Sohag Faculty of Agriculture Farm are presented in Table 1.

Table 1 : Average of the monthly degrees of temperature (maximum and minimum) at Sohag Faculty of Agriculture Experimental Farm during 2003/2004 season.

Temp. ^{0}C	Nov.	Dec.	Jan.	Feb.	Mar.	Apr.	May
Max.	27.5	21.6	19.9	22.5	26.4	30.9	38.7
Min.	12.5	6.9	5.4	6.2	10.3	13.9	19.6

Heading date was measured as the number of days from planting to the day when 50% of the heads were extruded from the flag leaf sheath. At maturity, data were recorded on 10 guarded plants chosen at random from each plot in each replicate for 1000 grain weight (1000 GW) and grain yield per plant (GY/P).

In each environment, data were subjected to the analysis of variance to test the significance of the differences among the 15 genotypes (five parents and their ten F_1 hybrids) according to Cochran and Cox (1957). Combined data over the two environments were also subjected to the combined analysis of variance in order to test the interaction of genotypes with environments.

General combining ability (GCA) and specific combining ability (SCA) variances were partitioned from total genotypic variance in each environment according to Griffing (1956) as method 2, model 1. The combined analysis over the two environments was calculated to partition the mean squares of genotypes and the interaction of genotypes with environments into sources of variations due to GCA, SCA and their interactions with the environments (GCAXE and SCAXE). Moreover, GCA effect (g_i) for each parent and SCA effect (s_{ij}) for each cross were also estimated. The estimates of additive (σ^2_A), non-additive (σ^2_D) genetic variances and their interactions with environments (σ^2_AXE and σ^2_DXE) were calculated according to Matzinger and Kempthorne (1956).

Stress susceptibility index was computed according to Fisher and Maurer (1978) as follows:

$$S = [(1- Y_d / Y_p) /D]$$

Where:

Y_d = mean yield in stress environment.

Y_p = mean yield in non stress environment.

D = 1-(mean yield of all genotypes in stress / mean yield in non stress).

RESULTS AND DISCUSSION

Genotypic variations

The analysis of variance of the two planting dates and their combined data for the three studied traits are presented in Table 2. Mean squares of environments were found to be highly significant for all studied traits with overall means of normal date higher than those of stress conditions ones. The differences among genotypes under each of environment and the combined data were highly significant for the three studied traits. In addition, the mean squares of genotype x environment interaction were highly significant. This result suggested a differential response of the genotypes under normal and stress environments. Similar results were obtained by Kheiralla and Sherif (1992), Kheiralla (1994); El-Sherbeny (1999); Sheikh *et al.* 2000; Singh 2002 and Joshi *et al*, 2002.

Table 2: Analysis of variance and mean squares of the five parents and their ten F_1 hybrids for studied traits under normal (D_1) and Late (D_2) planting stressed conditions as well as their combined data (C):

S. V.	D.F.		Heading date			1000-grain weight			Grain yield plant		
	S	C	D_1	D_2	C	D_1	D_2	C	D_1	D_2	C
Environ. (E)	-	1	-	-	1205.60	-	-	203.40	-	-	667.49
Reps/ E	2	4	4.39	10.56	7.47	6.61	7.48	7.04	8.29	11.26	9.78
Genotypes(G)	14	14	32.88**	66.34**	76.87**	35.77**	60.15**	70.87**	38.26**	67.90**	86.36**
GxE	-	14	-	-	22.35**	-	-	25.05**	-	-	19.81**
Error	28	56	4.20	4.48	4.34	4.72	5.60	5.16	4.94	6.81	5.88

** Significant at 1% level of probability.

Performances of parents and their crosses

The results in Table 3 indicated that the mean performances of the five parents and their ten F_1 crosses were variable from normal (D_1) to late (D_2) planting dates. Heat stress conditions caused reduction about 8.53%, 6.64% and 20.31% in parental average for heading date, 1000 grain weight and grain yield per plant, respectively. While, reduction in the F_1 hybrids average was 7.69%, 5.84% and 19.37% for heading date, 1000 grain weight and grain yield per plant, respectively. The findings of Tashiro and Wardlaw, (1990), Kheiralla and Sherif, (1992), Stone and Nicolas,(1994) and Joshi et al (2002) were in agreement with the present results. Whereas, Gibson and Paulsen (1999) found that increasing temperatures reduced grain yield by 78% and grain weight by 29%.

The results indicated that Sakha 69 (P_1) and Dovin-2 (P_3) were the earliest parents under normal and heat stress conditions, respectively. In both environments, Sakha 69 (P_1) and Giza 164 (P_4) were found to be the best parents for grain yield per plant and 1000 grain weight, respectively. Regarding the F_1 hybrids, the cross combinations (P_1xP_4) and (P_1xP_3) in normal date planting as well as (P_1xP_3) and (P_3xP_4) in late planting conditions were the earliest hybrids. For 1000 grain weight, the crosses (P_3xP_4) and (P_4xP_5) under normal date, and (P_1xP_4) and (P_3xP_4) in late date were the most promising hybrids. While, the cross (P_1xP_3) and (P_1xP_4) were the best yielding hybrids under both environments.

Table 3: Mean performances of the five parents and their ten F_1 hybrids for studies trails under normal (D_1) and Late (D_2) planting stressed conditions as well as their combined data (C) in addition to the estimates of stress susceptibility index (S):

Genotypes	Heading date			1000-grain weight			Grain yield plant			S
	D_1	D_2	C	D_1	D_2	C	D_1	D_2	C	
Sakha 69 (P_1)	89.3	84.4	86.9	51.8	48.7	50.2	31.4	26.8	29.1	0.75
Gemmeiza 5 (P_2)	96.6	91.5	94.1	44.6	41.3	42.9	20.6	14.3	17.5	1.55
Dovin-2 (P_3)	94.2	80.3	87.3	49.7	46.8	48.3	28.2	24.7	26.4	0.70
Giza 164 (P_4)	91.4	82.1	86.8	53.5	50.9	52.2	25.1	22.2	23.7	0.60
Bau'S' (P_5)	97.3	90.6	93.9	41.4	37.2	39.3	22.6	13.8	18.2	1.95
Parents mean	93.8	85.8	89.8	48.2	45.0	46.6	25.6	20.4	23.0	
$P_1 \times P_2$	90.4	85.2	87.8	48.7	46.6	47.7	28.6	22.5	25.5	1.11
$P_1 \times P_3$	87.1	76.3	81.7	50.8	49.5	50.1	34.3	29.2	31.8	0.79
$P_1 \times P_4$	86.3	80.7	83.5	51.9	50.7	51.3	31.4	28.8	30.1	0.42
$P_1 \times P_5$	92.6	88.4	90.5	47.4	41.8	44.6	29.3	21.7	25.5	1.37
$P_2 \times P_3$	93.4	87.5	90.5	46.7	45.4	46.1	26.1	18.6	22.3	1.53
$P_2 \times P_4$	90.7	85.2	87.9	50.6	48.6	49.6	27.5	21.1	24.3	1.21
$P_2 \times P_5$	94.5	89.3	91,9	45.5	40.4	43.0	24.7	16.4	20.6	1.79
$P_3 \times P_4$	89.1	77.8	83.5	52.8	50.5	51.7	29.8	26.2	28.0	0.63
$P_3 \times P_5$	95.3	88.2	91.7	50.2	45.3	47.7	27.2	22.4	24.8	0.93
$P_4 \times P_5$	90.2	81.1	85.6	52.4	49.2	50.8	25.4	21.8	23.6	0.74
Hybrids mean	91.0	84.0	87.5	49.7	46.8	48.3	28.4	22.9	25.7	
LSD 5%	3.42	3.54	3.40	3.63	3.95	3.70	3.71	4.36	3.96	
1%	4.61	4.77	4.52	4.88	4.77	4.92	4.99	5.88	5.27	
R% P	8.53			6.64			20.31			
R% F_1	7.69			5.84			19.37			

R% : Percentage of reduction due to heat stress.

: ($M.P_{D1}$ – $M.P_{D2}$ / $M.P_{D1}$) x 100.

: ($M.H_{D1}$ - $M.H_{D2}$ / $M.H_{D1}$) x100.

Stress susceptibility index (S)

The estimates of heat stress susceptibility index (S) based on grain yield per plant are presented in Table 3 for the five parents and their 10 crosses. It could be noticed that Sakha 69 (P_1), Dovin-2 (P_3) and Giza 164 (P_4) were relatively stress tolerant parents. On the other hand, Gemmeiza 5 (P_2) and Bau'S' (P_5) were susceptible parents to heat stress. Concerning the F_1 hybrids, (P_1xP_3), (P_1xP_4), (P_3xP_4), (P_3xP_5) and (P_4xP_5) crosses were relatively tolerant to heat stress, whereas the other five hybrids were susceptible.

In general, it could be observed that all cross combinations including Dovin-2 (P_3), Giza 164 (P_4) and two out of four crosses including Sakha 69 (P_1) gave (S) values less than the unity. These results indicate that the tolerant parents (P_1), (P_3) and (P_4) transmitted their genes controlling heat tolerance. It is also noticed that the crosses (P_1xP_3) and (P_1xP_4) gave the highest yield under both the two environments with susceptibility index less than unity. Consequently, these crosses could be considered a promising populations for isolating useful segregates to be cultivated under heat stress.

The correlation coefficients between stress susceptibility index (S) and each of grain yield per plant and heading date were also estimated. Grain yield per plant under stress conditions was negatively correlated with heat susceptibility index ($r = -0.34$). This finding indicated that grain yield per plant was the most variable trait for selection under heat stress conditions. On the contrary, heading date was positively correlated with (S) values ($r = 0.84$), suggesting that early genotypes were less susceptible to heat stress than late ones. Evidently, early genotypes escape from the heat stress and reach the grain filling stage when temperature is still adequate for greater yield.

Combining ability analysis

The results of combining ability analysis in Table 4 showed that both GCA and SCA variances were highly significant for all studied traits under each of planting date and their combined data. These indicate that all types of gene action are involved in the inheritance of these traits. In addition, the interactions of GCA x E and SCA x E mean squares were found to be highly significant for all studied traits, suggesting that the magnitude of all types of gene action fluctuated from normal date to stress date conditions which further complicated the problem of identification of promising parents and crosses. Therefore, selection for these traits under more environments would be effective. In this trend, similar findings were reported by Dasgupta and Mandol 1988; Menon and Sharma,1997; Joshi *et al*, 2002 and El-Seidy, 2003.

Table (4): Combining ability analysis of variance for all studied traits under normal (D_1) and Late (D_2) planting stressed conditions as well as their combined data (C):

S. V.		D.F.			Heading date				1000-grain weight	Grain yield plant	
	S	C	D_1	D_2	C	D_1	D_2	C	D_1	D_2	C
GCA	4	4	20.72**	43.97**	51.61**	25.18**	45.09**	53.80**	30.56**	57.72**	75.29**
SCA	10	10	7.06**	13.37**	15.23**	6.62**	10.04**	11.63**	5.63**	8.60**	10.19**
GCAXE	-	4	-	-	13.07**	-	-	16.47**	-	-	12.99**
SCAXE	-	10	-		5.20**	-	-	5.03**	-	-	4.05*
Error	28	50	1.40	1.49	1.45	1.57	1.87	1.72	1.65	2.27	1.96
GCA / SCA			2.93	3.29	3.39	3.80	4.49	4.62	5.43	6.71	7.39
GCAxE/SCA xE			-	-	2.51	-	-	3.27	-	-	3.21

*,** Significant at 5% and 1% levels of probability, respectively.

GCA effects (g_i)

Estimates of general combining ability of each parent (g_i) for all studied traits under the two environments and their combined data are given in Table 5. The results showed that Sakha 69 (P_1) and Giza 164 (P_4) were excellent combiners for earliness, heaver grain weight and high yielding under each of the two environments and their combined data, whereas, Gemmeiza 5 (P_2) and Bau`S` (P_5) were the poorest general combiners for the same traits. Moreover, the parent Dovin-2 (P_3) seemed to be a good general combiner for earliness and 1000 grain weight under stress condition and for grain yield per plant under each of the two environments and their combined data. It could be concluded that the parents Sakha 69 (P_1), Giza 164 (P_4) and Dovin-2 (P_3) possessed more desirable additive genes for all studied traits under each of the two environments and their combined data.

Table (5): Estimates of general combining ability effects (gi) of each parent for studied traits under normal (D_1) and heat stress (D_2) conditions as well as their combined data (C):

Parents	Heading date			1000-grain weight			Grain yield plant		
	D_1	D_2	C	D_1	D_2	C	D_1	D_2	C
Sakha 69 (P1)	-2.34**	-1.15**	-1.73**	1.03*	1.26*	1.13*	3.07**	3.37**	3.22**
Gemmeiza 5 (P2)	1.55**	3.25**	2.41**	-2.07**	-1.94**	-2.00**	-2.39**	-3.57**	-2.98**
Dovin-2 (P3)	-0.28	-2.43**	-1.06*	0.67	1.02*	0.86	1.27**	1.94**	1.59**
Giza I64 (P4)	-1.75**	-2.63**	-2.19**	2.78**	3.38**	3.08**	0.08	1.44**	0.69
Bau`S` (P5)	2.26**	2.96**	2.58**	-2.41**	-3.72**	-3.07**	-1.44**	-3.19**	-2.52**
S. E. (gi)	0.40	0.41	0.41	0.42	0.46	0.44	0.43	0.51	0.47

*,** Significant at 5% and 1% levels of probability, respectively.

SCA effects (S_{ij})

Estimates of SCA effects (S_{ij}) of each cross for all studied traits at the two environments and their combined data are presented in Table 6. The results showed that the cross combination (P_1xP_3), which resulted from crossing (good x good) general combiners, revealed significant SCA effects for earliness and high yielding under normal and stress conditions. The two cross (P_2xP_4) and (P_3xP_5), involved one good and one poor general combiners, exhibited significant SCA effects for grain yield per plant and 1000 grain weight, respectively, under each of the two environments and their combined data. Desirable SCA effects towards earliness and heaver grain weight were obtained by the cross (P_4xP_5), which include one good and one poor general combiners, under each of the two environments and their combined data.

It could be concluded that the excellent cross combinations in this study were obtained from (good x good) and (good x poor) general combiners. Consequently, it was not necessary that parents having estimates of GCA effects would also give high estimates of SCA effects in their respective cross combinations. Similar results were obtained by Sheikh *et al.* (2000); Singh (2002) and Joshi *et al*, (2002).

Table 6: Estimates of specific combining ability (Sij) of each cross for all studied traits under non stress (D_1) and heat stress (D_2) conditions as well as their combined data (C):

Crosses	Heading date			1000-grain weight			Grain yield plant		
	D_1	D_2	C	D_1	D_2	C	D_1	D_2	C
$P_1 \times P_2$	-0.70	-1.47	-1.11	0.54	1.08	0.87	0.44	0.67	0.50
$P_1 \times P_3$	-2.73**	-4.69**	-3.74**	-.010	1.02	0.41	2.47*	2.86*	2.65*
$P_1 \times P_4$	-1.50	-0.09	-0.81	-1.12	-0.14	-0.61	0.93	2.96*	1.95
$P_1 \times P_5$	0.78	2.01	1.42	-0.42	-1.94	-1.16	0.62	-0.52	0.04
$P_2 \times P_3$	-0.32	2.11	0.92	-1.10	0.12	-0.46	-0.25	-1.80	-1.08
$P_2 \times P_4$	-0.99	0.01	-0.55	0.68	0.96	0.81	2.80*	2.69*	2.76*
$P_2 \times P_5$	-1.20	-1.49	-1.33	0.78	-0.14	0.37	1.49	1.13	1.34
$P_3 \times P_4$	-1.32	-1.70	1.48	0.14	-0.09	0.06	1.13	0.78	0.95
$P_3 \times P_5$	0.87	3.10**	1.95	2.74*	2.81*	2.76*	0.32	1.61	0.97
$P_4 \times P_5$	-2.20*	-3.80**	-3.03**	2.83**	3.35**	3.09**	-0.13	1.51	0.67
S. E. (Sij)	1.03	1.06	1.05	1.09	1.19	1.14	1.12	1.31	1.22

*,** Significant at 5% and 1% levels of probability, respectively.

Nature of gene actions

Estimates of all types of gene action for all studied traits under the two planting dates and their combined data are presented in Table 7. The results revealed that the magnitudes of additive genetic variance (σ^2_A) were positive and lower than those of non additive ones (σ^2_D) for heading date under each of the environment and their combined data. These results could be verified by the ratios $(\sigma^2_D/\sigma^2_A)^{½}$ which were more than unity for heading date under each of the two environments and their combined data, confirming that non additive gene action (including dominance) played a major role in the inheritance of this trait. On the other hand, the estimates of additive variance (σ^2_A) were higher than those of non additive ones (σ^2_D) for 1000 grain weight and grain yield per plant at non stress and stress conditions as well as their combined data, verifying by the ratios $(\sigma^2_D/\sigma^2_A)^{1/2}$ which were less than unity. These indicate the importance of additive gene action in the genetic control of these traits under each of the two environment and their combined data.

Regarding the interactions, the magnitude of σ^2_AxE variance was positive and lower than those of σ^2_DxE ones for heading date, verifying by the ratio $(\sigma^2_D xE/\sigma^2_A xE)^{1/2}$ which was more than unity. These results reveal that non additive gene effects were more affected by planting dates than additive ones for earliness. In contrast, the ratio $(\sigma^2_D xE/\sigma^2_A xE)^{1/2}$ were less than unity for 1000 grain weight and grain yield per plant, indicating that additive gene effects were more influenced by heat stress than non additive ones. Therefore, selection in these genetic materials could be practiced under heat stress for 1000 grain weight and grain yield per plant. Joshi *et al*, (2002) reported that additive and non-additive gene effects controlled the expression of studied traits under two sowing dates. Whereas, Dhanda and Sethi (1996) noticed that additive gene effects appeared to be the important factor contributing to the genetic control of days to heading, 1000 grain weight and grain yield per plant under both environments

Table 7: Estimates of genetic parameters for all studied traits under normal (D_1) and heat stressed (D_2) conditions as well as their combined data (C):

Genetic Parameters	Heading date			1000-grain weight			Grain yield plant		
	D_1	D_2	C	D_1	D_2	C	D_1	D_2	C
σ^2_A	3.90	8.74	4.07	5.30	10.01	4.36	7.12	14.03	8.02
σ^2_D	5.66	11.88	5.02	5.05	8.17	3.31	3.98	6.33	3.07
σ^2_A x E	-	-	2.25	-	-	3.33	-	-	2.56
σ^2_D x E	-	-	3.75	-	-	3.30	-	-	2.09
$\sigma^2 e$	1.40	1.49	1.45	1.57	1.87	1.72	1.65	2.27	1.96
$(\sigma^2_D/\sigma^2_A)^{½}$	1.20	1.17	1.11	0.98	0.82	0.87	0.75	0.67	0.62
$(\sigma^2_D xE/\sigma^2_A xE)^{½}$	-	-	1.29	-	-	0.99	-	-	0.90
H^2_b %	87.22	93.26	54.96	86.82	90.67	47.88	87.06	89.97	62.66
H^2_n %	35.58	39.53	24.61	44.46	49.93	27.22	55.84	62.00	45.31

Estimates of heritability

The estimates of broad sense heritability (Table 7) were larger than their corresponding narrow sense for all studied traits under two environments and combined data. The results indicate that the largest values of broad sense heritability were observed for heading date (87.22% and 93.26%) under normal and stress conditions, respectively. While, the largest estimates of narrow sense heritability were obtained for 1000 grain weight (44.46% and 49.93%) and grain yield per plant (55.84% and 62.00%) under normal and stress conditions, respectively.

Therefore, these results presented additional evidence about the important of non additive genetic variance for heading date and additive genetic variance for both 1000 grain weight and grain yield per plant in this set of materials under normal and heat stress conditions. Kheiralla and Sherif (1992) stated that narrow sense heritability estimates were relatively high for both 1000 grain weight and days to heading, and moderate for grain yield per plant under normal and stress planting date conditions. However, El-Sherbeny (1999) obtained moderate narrow sense heritability values for days to heading and grain yield per plant under both environments. While, Dhanda and Sethi (1992) found that 1000 grain weight and days to heading had moderate to high heritability values under both environments.

It could be concluded that plant breeders could use heading date and grain yield as indicators for identifying desirable parents and crosses. For instance, the cross combinations including Dovin-2 (P_3), Giza 164 (P_4) and two out of four crosses including Sakha 69 (P_1) gave (S) values less than the unity, indicating that these tolerant parents (P_1), (P_3) and (P_4) transmitted their genes controlling heat tolerance. Moreover, the crosses (P_1xP_3) and (P_1xP_4) gave the highest yield under both environments with susceptibility index less than unity. In addition, heading date was positively correlated with (S) values (r = 0.84), suggesting that early genotypes escape from heat stress and reach the grain filling stage when temperature is still adequate for greater yield. Consequently, these crosses could be considered a promising populations for isolating useful segregates for cultivating under heat stress. Estimates of nature of gene action and narrow sense heritability in these promising populations proved that selection for heat tolerance could be effective in early segregating generations.

REFERENCES

Bakheit, B. R.; M. G. Mosaad; M. A. El-Morshidy and A.M. Tamam (1989): Inheritance of yield in some durum wheat crosses. (Triticum turgidum L.). Assiut J. Agric. Sci., 20 (3): 221-234.

Cochran, W. G. and G. M. Cox (1957) : Experimental Designs. 2nd edition, John Wily Sons, New York, U.S.A.

Dasgupta, T. and A. B. Mandol (1988): Diallel analysis in wheat. Indian J Genet 48(2): 167-170.

Dhanda, S. S. and G.S. Sethi (1996): Genetics and interrelationships of grain yield and its related traits in bread wheat under irrigated and rainfed conditions. Wheat Information Service, 83: 19-27.

El-Seidy, E.H. (2003): A diallel cross analysis in F_1 and F_2 generations for earliness, yield and its components of barley under favorable and water stress conditions. Egypt. J. Plant Breed. 7 (1): 643-663. El-Sherbeny, G. A .R. (1999) : Estimates of heterosis and nature of gene action under drought stress and favourable conditions in bread wheat (*Triticum aestivum* L.). Mansoura J.Agric. Sci., 24 (12): 7341-7352.

Fisher, R. A. and R. Maurer (1978) : Drought resistance in spring wheat cultivars. 1- Grain yield responses. Aust. J. Agric. Res., 29 : 892-912.

Gibson, L.R. and G.M. Paulsen (1999): Yield Components of Wheat Grown under High Temperature Stress during Reproductive Growth. Crop Sci., 39:1841-1846.

Griffing, B. (1956) : Concept of general and specific combining ability in relation to diallel crosses systems. Aust. J. Biol. Sci., 9 : 436-493.

Joshi, S.K. , S.N. Sharma, D.L. Singhania and R.S. Sain (2002): Genetic analysis of quantitative and quality traits under varying environmental conditions in bread wheat. Wheat Information Service, 95: 5-10

Keiralla, K. A. and T. H. I. Sherif (1992) : Inheritance of earliness and yield in wheat under heat stress. Assit J. Agric. Sci., 23 (1):105-126.

Keiralla, K.A. (1994) : inheritance of earliness and its relation with yield and drought tolerance in spring wheat. Assiut J. Agric. Sci., 25 (5): 129-139.

Matzinger, D. F. and O. Kempthorne (1956) : The modified diallel table with partial inbreeding and interactions with environment. Genetics, 41 822-833.

Menon, U. and S.N. Sharma (1997) Genetics of yield determining factors in spring wheat over environments. Indian J Genet 57(3): 301-306.

Rajaram, S (1988): Breeding and testing strategies to develop wheats for rice-wheat rotation areas. In: Klatt AR (ed) Wheat production constraints in tropical environments. CIMMYT, Mexico DF: 187-196.

Sharma, R. F. and J.P. Tandon (1997): Combining ability analysis in relation to heat stress for yield, its components and some growth durations in wheat. Wheat Information Service, 85: 43-44.

Sharma, S.N.; V.K. Bhatnagar; M.S. Mann; U.S. Shekhawat and R.S. Sain (2002): Maximization of wheat yields with a unique variety in warmer areas. Wheat Information Service,95: 11-16

Sheikh, S., I. Singh and J. Singh (2000): Inheritance of some quantitative traits in bread wheat (*T. aestivum* L. em Thell.). Ann Agric Res 21(I): 51-54.

Shipler, L.and A. Blum (1986): Differential reaction of wheat cultivars to hot environments. Euphytica, 35:483-492.

Singh, H. (2002): Genetic architecture of yield and its associated traits in bread wheat. PhD Thesis, Raj Agric Univ, Bikaner, India.

Stone, P.J. and M. E. Nicolas (1994): Wheat cultivars vary widely in their responses of grain yield and quality to short periods of post-anthesis heat stress. Aust. J. Plant Physiol., 21: 887-900.

Tashiro, T. and I. F. Wardlaw (1990): The effect of high temperature at different stages of ripening on grain set, grain weight and grain dimensions in the semi-dwarf wheat `Banks'. Ann. Bot. (London), 65: 51-61.

طبيعة فعل الجين لصفتي التزهير والمحصول في قمح الخبز تحت ظروف التقسية الحرارية

جلال أحمد رزق الشربينى
قسم النبات الزراعي (فرع الوراثة) – كلية الزراعة بسوهاج – جامعة جنوب الوادي – مصر

- تم إجراء هذا البحث لدراسة السلوك الوراثي لصفات التزهير ووزن ا لألف حبة ومحصول الحبوب للنبات الواحد وذلك باستخدام نظام التهجين النصف دائري بين خمسة أصناف من قمح الخبز تحت الظروف الملائمة (ميعاد الزراعة العادي) وظروف التقسية الحرارية (ميعاد الزراعة المتأخر).**ويمكن تلخيص أهم النتائج فيما يلي:**
- كان التفاعل بين التراكيب الوراثية والبيئة معنوي وهذا يدل علي اختلاف سلوك التراكيب الوراثية المستخدمة في الدراسة باختلاف مواعيد الزراعة.
- أدي ميعاد التزهير المتأخر إلي نقص في عدد الأيام حتى التزهير ووزن الـ١٠٠٠ حبة ومحصول حبوب النبات الواحد في هجن الجيل الأول بمقدار ٧,٦٩%، ٥,٨٤%، ١٩,٣٧% علي الترتيب.
- أظهرت النتائج أن قيم معامل الحساسية للتقسية الحرارية لكل الهجن التي تشترك فيها الأباء P_3, P_4 وأثنين من الهجن التي يشترك فيه الأب P_1 كانت أقل من الوحدة، لذا فإنها تعتبر مقاومة للحرارة. كما أظهر معامل الحساسية للحرارة ارتباطا موجبا(٠,٨٤) مع ميعاد التزهير وارتباطا سالبا(-٠,٣٤) مع محصول حبوب النبات.
- أوضحت النتائج أن الأباء P_1, P_3, P_4 لها قدرة عامة عالية علي التالف لكل الصفات المدروسة في كلتا البيئتين والتحليل المشترك بينهم. كما كانت الهجين ($P_1 x P_3$) قدرة خاصة علي التالف لصفتي التزهير ومحصول النبات الواحد تحت الظروف الملائمة وظروف الحرارة العالية. بيتما أظهرت الهجن ($P_2 x P_4$)، ($P_3 x P_4$) قدرة خاصة عالية علي الإئتلاف لصفتي محصول حبوب النبات الواحد ووزن الألف حبة علي الترتيب في كلتا البيئتين والتحليل المشترك لهم.
- أظهرت نتائج التحليل الوراثي أن التباين الوراثي المضيف كان أكثر أهمية من التباين الوراثي غير المضيف لصفتي وزن الألف حبة ومحصول حبوب النبات الواحد، بينما كان التباين الوراثي غير المضيف أكثر أهمية في وراثة صفة التزهير. وكان التفاعل بين الجينات المضيفة والبيئة أكبر من التفاعل بين الجينات غير المضيفة والبيئة لصفتي التزهير ووزن الألف حبة مما يدل علي زيادة تأثر الجينات غير المضيفة بالبيئة لهذه الصفات. وعلي العكس من نلك وجد أن الجينات غير المضيفة أكثر تأثرا بالبيئة لصفة التزهير.
- كانت أعلي قيم لمعامل التوريث في المدى الواسع لصفة التزهير (٨٧,٢٢% ، ٩٣,٢٦%) تحت الظروف الملائمة وظروف الحرارة العالية علي الترتيب.بينما كانت أعلي قيم معامل التوريث في المدى الضيق لصفات وزن الألف حبة (٤٤,٤٦% ، ٤٩,٩٣%) ومحصول حبوب النبات الواحد (٥٥,٨٤%، ٦٢,٠٠%) وذلك تحت الظروف الملائمة وظروف الحرارة العالية علي الترتيب.
- طبقا لنتائج التحليل الوراثي للصفات تحت الدراسة فإن الانتخاب المبكر في الأجيال الانعزالية للهجن المبشرة قد يكون مجديا تحت ظروف الحرارة العالية.