J. Agric. Sci. Mansoura Univ., 33 (12): 8525 - 8538, 2008

COMBINING ABILITY, GENE ACTION AND HERITABILITY OF SOME DIALLEL VARIETAL CROSSES IN BREAD WHEAT UNDER NORMAL IRRIGATION AND DROUGHT CONDITIONS

Abdel-Moneam, M. A.
Agron. Dept., Fac. of Agric., Mansoura Univ. Egypt.

ABSTRACT

Five bread wheat varieties representing different agronomic characters were crossed in a half-diallel model in 2005/2006 season. The five parents and their 10 F_1 crosses were evaluated under normal irrigation and drought conditions in 2006/2007 season to study the mode of gene action for some wheat traits.

Mean squares of genotypes, general and specific combining ability were significant for all traits under normal and drought conditions, except specific combining ability for plant height at normal irrigation. The best combiners at both environmental conditions for of days to heading, days to maturity (earliness), flag leaf area and spikes number/plant was Sakha61; for plant shortness were Sakha8 and Sakha-93; for kernels/spike, 100-kernel weight and grain yield/plant were Gemmeiza9 and Giza168. These results indicated that these genotypes could be considered as good combiners for improving these traits. The best combinations at both conditions for days to heading was Giza168×Gemmeiza9, for days to maturity was Sakha61× Gemmeiza9; for flag leaf area was Giza168× Sakha61; for plant height (shortness) and 100-kernel weight was Sakha61×Sakha-93; for spikes/plant and kernels/spike was Sakha8×Gemmeiza9; for grain yield/plant were Giza168 x Gemmeiza9 at normal condition and Sakha-93×Gemmeiza9, at drought condition. These crosses could be selected and used in breeding programs to improving these traits.

Both additive and dominance gene effects were significant for most traits at both conditions. The results showed that the role of partial dominance gene effects in controlling all traits under both studied conditions, except grain yield/plant at normal condition, 100-kernels weight at drought stress condition and spikes number/plant at both conditions, which controlled by over dominance gene effects. Each one of studied characters were governed at least by one gene group, except days to maturity and 100-kernel weight at normal condition; flag leaf area and grain yield/plat at stress conditions, which were governed at least by two gene groups. Grain yield/plant at normal condition and spikes number/plant at stress condition were governed by at least three gene groups. Also, spikes number/plant at normal condition was governed by at least four gene group. Heritability in narrow sense ($h^2_{n.s}$) estimates were moderate or high for all studied traits at both conditions, reflecting the role of additive gene action in governing these traits, therefore selection for these traits could be applied in early segregating generations, except spikes number/plant at both conditions, which had low values of heritability in narrow sense.

The parents Sakha-61 and Giza-168 and Gemmeiza-9 could be used in breeding for drought tolerance. Selection for days to heading, days to maturity, flag leaf area, plant height and kernels/spike at both conditions and for grain yield/plant at drought condition may be practiced in early segregating generations to improved bread wheat with respect to these genetic materials.

Keywords: Wheat, Crosses, GCA, SCA, Gene Action, Heritability, Drought

INTRODUCTION

Hybridization between the local cultivars and exotic materials was carried out to increase genetic variability because selection among Egyptian wheat cultivars for increasing grain yield and its components may not be effective. Quantitative economic traits in wheat are highly influenced by environmental conditions. Among the environmental stresses, drought is considered the most limiting factor of the plant productivity in the most areas of the world. When drought is prolonged crops fail and people may starve.

Information on the relative importance of general and specific combining ability is important in the development of efficient wheat breeding programs. It is very essential that the breeder evaluated the available germplasm *per se* and in crosses. In this regard, several studies have been reported in wheat, Mohamed (2004) reported that mean squares due to general and specific combining ability were highly significant for plant height and grain yield/plant at normal and drought stress conditions. El-Danasory (2005) reported that GCA/SCA ratio was more than unity for days to heading at normal and water stress conditions, number of kernels/spike and days to maturity at normal and water stress conditions, respectively. Salem and Abdel-Dayem (2006) showed that the parents Sahel 1, Gemmeiza-9 and Sakha-61 expressed the highest GCA for kernels spike^{-1}, as Sahel 1 and Gemmeiza-9 for spikes plant^{-1} , while Giza 164 was the highest for 100-kernel weight and grain yield plant^{-1}, also, Sahel 1 had good potential for grain yield plant^{-1}. And, they added that the highest SCA values, under drought conditions, were detected for the cross Sahel 1 x Sakha 94 for kernels number spike^{-1} and 100-kernel weight, Giza 164 x Sakha-61 for spikes number plant^{-1} and kernels number spike^{-1} , and Sahel 1 x Gimmeiza 9 for spikes plant^{-1} and grain yield plant^{-1}. Also, Sultan, *et al.,* (2006) found that GCA and SCA mean squares were significant for all studied traits at both normal and drought conditions, except SCA for days to heading, days to maturity and spikes number plant^{-1} under water stress condition, GCA/SCA ratio were more than unity for all traits at both conditions, except flag leaf area, kernels/spike under water stress condition, spikes/plant at normal condition, 100-kernel weight and grain yield/plant under both conditions, suggesting that additive genetic effects were more important in controlling these traits. In addition, Salama (2007) showed that the mean squares of GCA and SCA were significant for all characters (days to heading, flag leaf area, spikes/plant, grains/spike, 1000-grain weight and grain yield/plant) under various number of irrigations, and added that, the wheat cultivars, Gemmeiza 7 and Gemmeiza-9 proved to be good general combiners, and wheat crosses; Sakha-93 x Gemmeiza-9 and Gemmeiza 7 x Sids 1 could be considered promising crosses and the best crosses combinations displayed for amount of heterotic effects for grain yield/plant.

Assessment and quantifying the type of gene action in wheat were detected by some investigators. Ashoush *et al.* (2001) reported that heritability estimates for plant height, days to heading and yield components were medium to high (more than 50%). Moreover, Farhat (2005) reported that additive gene effects were more important for days to heading, grain filling period, total chlorophyll content, plant height and 100-kernel weight at normal and water stress conditions. While dominance gene effects were more important for days to maturity, grain filling rate and grain yield/ plant. Also, Sultan, *et al.* (2006) indicated that the genetic component i.e. additive and dominance were highly significant for most studied traits. Their results showed the role of partial dominance gene effects in controlling all traits under both conditions, except number of spikes/plant at normal condition, number of kernels/spike, grain yield/plant at water stress condition, and 100-kernel weight at both conditions, which controlled by over dominance gene effects. Their results clearly showed that each one of studied characters were governed at least by one gene group, except days to maturity at normal condition, plant height and grain yield/plant at water stress, which were governed at least by two gene groups, and plant height at normal condition and 100-kernel weight at both conditions were governed by at least by three gene group. And they added that the parents Line 1 and Sakha 94 could be used in breeding for drought tolerance, and selection for days to heading, days to maturity, plant height at both conditions may be practiced in early segregating generations to improved bread wheat. Finally, Salama (2007) found that mean squares for types of gene action according to method of Jones (1956), additive genetic variance was significant for all studied traits under various irrigation treatments, whereas the dominance genetic components was significant for all traits except spikes number/plant for normal irrigation (I_1, 6 irrigations). On the other hand, using second degree statistic (Hayman, 1954) revealed that dominance genetic variance accounted for days to heading, spikes/plant (I_1, I_2, and I_3), grains/spike (I_1) and grain yield/plant (I_1 and I_2) resulting in $(H_1/D)^{0.5}$ was more than unity, and both positive and negative alleles ($H_2/4H_1$) were not equally distributed among parents for all traits, except spikes/plant (I_1). In addition, heritability in narrow sense was more than 50% for flag leaf area and days to heading (I_1, I_2, and I_3) as well as spikes number/plant under drought.

Therefore, the present investigation was designed to measure the combining ability effects and the mode of gene action in the inheritance of some traits of wheat, and to estimate the genetic components and heritability for all suited traits under normal watering and water stress conditions.

MATERIALS AND METHODS

The genetic materials used in this investigation as parents included five bread wheat varieties, representing a wide range of diversity for several agronomic characters. The parents names and pedigree are presented in Table (1). In 2005/2006 season, the parental varieties were sown at various dates in order to overcome the differences in flowering time. All possible cross combinations excluding reciprocals were made among the five varieties, giving 10 crosses.

The monthly average amount of rainfall of experimental area is presented in Table (2).

Table 1: Parents names and pedigree

No	Genotype	Pedigree
1	Giza-168 (P1)	MRL/BUC// Seri CM 93046-8M-04-OM-2Y-OB-062
2	Sakha-8 (P2)	Cno 67//SN64/KLRE/3/8156 PK 3418-6S-0S-0S
3	Sakha-61 (P3)	INIA/RL4220//7C/Yr"S" CM15430-2S-5S-0S
4	Sakha-93 (P4)	Sakha 92/TR8 10328 S.8871-1S-2S-1S-0S
5	Gemmeiza-9 (P5)	Ald"S"/Huac//Cmh74A.630/Sx CGM4583-5GM-1GM-0GM

Table 2: Monthly average of total rainfall during (2006/2007) at El-Mansoura City, El-Dakahlia Governorate

Month	Nov.2006	Dec.2006	Jan.2007	Feb.2007	Mar.2007	Apr.2007	May.2007
Rainfall (ml)	4	2	-	14	2	—	—

In 2006/2007 season, the fifteen entries (5 parents and 10 F_1) were evaluated in two separate irrigation regime experiments. The first experiment (normal conditions) was irrigated four times after planting irrigation i.e. five irrigation were given through the whole season. The second experiment (drought conditions) was given one surface-irrigation 27 days after the establishment (two irrigations were given through the whole season). Each of the two experiments was fertilized with 15 kg P_2O_5/fad, 24 kg K_2O/fad in one dose during soil preparing and 75 kg N/fad was added in two doses. The first dose was 30% with sowing and the second was 70% with the first irrigation (after 27 days from sowing). The two experiments were designed in randomized complete block design with three replications in the Experimental Farm at the Experimental Station of the Faculty of Agriculture, Mansoura University, El-Dakahlia Governorate, Egypt.

Each replicate consisted of 15 rows (genotypes) as well as two rows (border) 4 m long and 25 cm apart with 20 cm between plants. Twenty grains were planted in each row and manually drilled in the rows. Each experiment was surrounded by a wide border (3 m) to minimize the underground water permeability. All other cultural practices, except irrigation, were applied as recommended for wheat cultivation. The two outside plants for each row and the two external rows of each plot were excluded to eliminate the border effect.

The studied characters were, days to heading, days to maturity, flag leaf area (cm^2), plant height (cm), number of spikes/plant, number of kernels/spike, 100-kernel weight (gm) and grain yield/plant (gm). Characters were determined from 10 plants per plot for all characters, except flag leaf area trait, which was determined from 5 plants per plot.

The data obtained for each trait were analyzed on plot mean basis in both parents and F_1 generation. An ordinary analysis using Griffing (1956) method 2 model 1 was applied to estimate general combining ability (GCA) and specific combining ability (SCA) effects, as shown in Table 3.

Table 3: Analysis of variance from method 2 model 1 and expected mean squares for combining ability analysis.

S.V	d.f	M.S	E.M.S
Genotypes			
GCA	P-1	M_g	$\sigma^2_e + (P+2)(1/P-1)\sum g^2_i$
SCA	P (P-1)/2	M_s	$\sigma^2_e + 2/P(P-1)\sum_i \sum_j S^2_{ij}$
Error	(r-1)(c-1)	M_e	σ^2_e

Where: Me= the error mean squares of the main randomized complete block design divided by number of replications (Me = Me/r) , P= number of parents.

The relative importance of GCA to SCA was expressed as follows:

K^2 GCA / K^2 SCA = $[(MS_{GCA} - MS_e)/(P + 2)] / (MS_{SCA} - MSe)$, where: MS= mean squares, P= No. of parents and K^2= is the average squares of the effects.

The data were analyzed using Hayman (1954 and 1958) to partition the total genetic variance to consistent parts; additive and dominance genetic effects. Heritability in broad sense ($h^2_{b.s}$) and heritability in narrow sense ($h^2_{n.s}$) were estimated using the formula of Mather and Jinks (1982), for the F_1 generation as follows:

$$h^2_{n.s} = (1/2D + 1/2H_1 - 1/2H_2 - 1/2F) / (1/2D + 1/2H_1 - 1/4H_2 - 1/2F + E)$$
$$h^2_{b.s} = (1/2D + 1/2H_1 - 1/4H_2 - 1/2F) / (1/2D + 1/2H_1 - 1/4H_2 - 1/2F + E)$$

RESULTS AND DISCUSSION

Analysis of variance for the studied traits under normal irrigation and drought conditions are presented in Table 4. The results indicated clearly that mean squares of genotypes were significant for all traits under normal and drought conditions. These results reflected an indication to the presence of real differences between the studied genotypes for these traits. These results agree with those previously reported by Mohamed (2004), Farhat (2005) and Sultan, *et al.* (2006)

General and Specific combining ability mean squares presented in Table (4) were highly significant for all studied traits at normal and drought conditions, except specific combining ability for days to maturity at water stress condition was significant only, while specific combining ability for plant height at normal irrigation was non-significant. The GCA/SCA ratio was more than unity for all studied traits at both conditions except, spikes number per plant and grain yield per plant at both conditions, and 100-kernel weight at drought condition were less than unity. This means that studied traits are predominantly controlled by additive gene action. Therefore, it could be concluded that selection procedures based on the accumulation of additive gene effect would be more effective in the early segregating generations. On the other hand, trait of spikes number per plant and grain yield per plant at both conditions, and 100-kernel weight at drought condition were mainly controlled by non-additive gene action. These results are in general agreement with those previously reported by Mohamed (2004), El-Danasory (2005), Sultan, *et al.* (2006) and Salama (2007).

Table 4: Mean squares from analysis of variance, for general and specific combining abilities under normal irrigation and drought conditions of all studied traits.

S.O.V	d.f	Days to heading		Days to maturity		Flag leaf area, cm^2		Plant height, cm	
		Normal	drought	Normal	drought	Normal	Drought	Normal	Drought
Genotypes	14	21.42**	16.82**	13.27**	10.76**	71.57**	134.2**	49.78**	69.09**
GCA	4	67.96**	55.91**	44.71**	36.18**	219.8**	345.8**	168.2**	215.6**
SCA	10	2.81**	1.18**	0.69**	0.587*	12.25**	49.51**	2.13	10.46
Error	28	0.37	0.33	0.265	0.265	0.648	0.733	6.236	4.58
GCA/SCA	-	**3.96**	**9.34**	**14.94**	**15.93**	**2.70**	**1.01**	**5.63**	**5.13**

Table 4: Continued

S.O.V	d.f	No. of spikes/plant		Kernels No. /spike		100-kernel weight, gm		Grain yield/plant, gm	
		Normal	drought	Normal	drought	Normal	Drought	Normal	Drought
Genotypes	14	3.18**	3.24**	50.23**	46.17**	0.23**	0.166**	16.42**	10.50**
GCA	4	3.80**	2.45**	143.4**	124.0**	0.611**	0.377**	28.81**	24.01**
SCA	10	2.94**	3.55**	12.96**	15.02**	0.074**	0.082**	11.47**	5.096**
Error	28	0.232	0.276	0.757	0.751	0.0009	0.022	0.181	0.488
GCA/SCA	-	**0.19**	**0.09**	**1.67**	**1.23**	**1.29**	**0.83**	**0.36**	**0.73**

Table 5: Means of studied traits as affected by the interaction between wheat genotypes and irrigation treatments.

Genotype / Trait	Days to heading		Days to maturity		Flag leaf area, cm^2		Plant height, cm	
	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress
1- G. 168	91.3	89.3	146.7	142.7	47.30	35.23	113.3	104.0
2- Skh. 8	94.7	92.3	150.3	146.7	53.47	41.37	104.7	93.0
3- Skh. 61	90.3	88.7	146.3	144.0	64.37	57.37	110.7	101.7
4- Skh. 93	92.0	90.3	149.3	146.3	55.47	51.97	107.3	99.0
5- Gem. 9	100.0	97.3	153.7	149.7	50.47	35.73	120.0	108.0
6- G. 168 x Skh. 8	91.7	90.7	148.0	145.7	49.13	45.37	111.3	101.0
7- G. 168 x Skh. 61	91.7	90.0	145.7	143.3	62.07	56.30	114.0	103.7
8- G. 168 x Skh. 93	90.3	89.0	147.7	144.7	53.47	44.60	111.7	98.7
9- G. 168 x Gem. 9	93.7	92.3	149.7	146.3	49.03	46.40	117.3	108.7
10- Skh. 8 x Skh. 61	93.7	91.3	148.3	145.7	58.73	49.40	108.7	97.0
11- Skh. 8 x Skh. 93	92.3	91.0	149.3	147.0	55.53	47.47	106.7	93.7
12- Skh. 8 x Gem. 9	96.3	94.0	150.7	148.3	53.37	44.87	112.3	103.0
13- Skh. 61 x Skh. 93	90.3	88.7	147.3	146.0	59.33	56.30	109.0	95.3
14- Skh. 61 x Gem. 9	93.7	92.3	149.0	146.0	57.43	49.03	115.0	105.0
15- Skh. 93 x Gem. 9	95.7	93.7	151.3	148.3	54.80	48.40	112.7	102.7
F-test	N.S		**		**		N.S	
LSD 0.05	-		0.84		1.36		-	
LSD 0.01	-		1.00		1.62		-	

Table 5: Continued

Trait / Genotype	No. of spikes/plant		No. of kernels/spike		100-kernels weight, gm		Grain yield/plant, gm	
	Normal	Stress	Normal	Stress	Normal	Stress	Normal	Stress
1- G. 168	17.33	14.33	66.67	64.33	4.98	4.80	38.97	25.90
2- Skh. 8	16.67	13.67	62.00	58.67	4.29	4.56	33.87	22.70
3- Skh. 61	18.67	14.33	63.33	61.00	4.44	4.33	35.63	19.33
4- Skh. 93	17.33	14.00	66.00	64.33	5.02	4.87	36.67	20.47
5- Gem. 9	16.33	13.33	76.33	71.67	4.80	4.63	37.80	22.73
6- G. 168 x Skh. 8	18.67	14.67	67.33	64.33	4.78	4.49	37.93	24.70
7- G. 168 x Skh. 61	19.33	16.33	69.33	67.67	4.83	4.65	39.70	23.47
8- G. 168 x Skh. 93	18.67	15.33	71.67	69.00	5.11	4.90	42.00	25.10
9- G. 168 x Gem. 9	18.67	15.00	73.33	71.00	5.15	5.01	42.93	25.43
10- Skh. 8 x Skh. 61	19.67	16.67	64.67	61.67	4.52	4.40	37.97	22.03
11- Skh. 8 x Skh. 93	18.33	14.67	64.33	62.00	4.82	4.62	37.80	22.87
12- Skh. 8 x Gem. 9	18.67	15.67	72.67	69.67	4.86	4.65	38.97	23.53
13- Skh. 61 x Skh. 93	19.67	16.67	66.00	63.00	5.14	4.97	38.80	22.60
14- Skh. 61 x Gem. 9	19.33	15.67	68.67	64.67	4.69	4.37	39.83	23.83
15- Skh. 93 x Gem. 9	18.33	14.67	70.67	68.33	5.24	5.04	41.10	25.63
F-test	N.S		N.S		*		**	
LSD 0.05	-		-		0.17		0.94	
LSD 0.01	-		-		-		1.13	

* and ** = significant at 0.05 and 0.01 probability, respectively.

The results in table 5 indicated that days to maturity, flag leaf area, 100-kernel weight and grain yield/plant had significant interaction between genotypes and irrigation treatments. Suggested that wheat genotypes responded differently to water regime and the possibility of selection for the most tolerant genotypes may be successful and useful.

It could be noticed earliest parents for maturity was Sakha-61, and the earliest cross was Giza-168xSakha-61 at normal irrigation. While, under water stress condition Giza-168 was the earliest of the parents and Giza-168 x Sakha-61 was the earliest cross for maturity. With respect to flag leaf area, results showed that Sakha-61 was the best of the parents under normal and stress conditions, and Giza-168 x Sakha-61 and Sakha-61x Sakha-93 were the best of the crosses at both conditions. For weight of 100-kerenl, the results in Table 5 clearly showed that the parent which had the highest weight of 100-kernel was Sakha-93, and the highest cross was Sakha-93 × Gemmeiza-9 at both conditions. Concerning grain yield/plant, results showed that the parent which had the highest grain yield/plant was Giza-168 at both conditions, and the highest cross was Giza-168 Gemmeiza-9 at normal irrigation condition and Sakha-93×Gemmeiza-9 at water stress condition.

Estimates of GCA effects for parents' varieties for all traits at both conditions are presented in Table (6). Significant positive and negative GCA effects were found for all studied traits. Based on GCA estimates, it could be concluded that the best combiners at both environmental conditions for days to heading were Sakha-61, Giza168 and Sakha-93; for days to maturity were Sakha-61 and Giza-168; for flag leaf area were Sakha-61 and Sakha-93; for plant height were Gemmeiza-9 and Giza-168 (for plant tallness plant) and Sakha-8 and Sakha-93 (for plant shortness); for spikes number/plant was Sakha-61; for kernels/spike were Gemmeiza-9 and Giza-168; for 100-kernel weight were Sakha-93 and Giza168; for grain yield/plant were Giza168 and Gemmeiza-9. These results indicated that these genotypes could be considered as good combiners for improving these traits.

Estimates of SCA effects of crosses for all studied traits at both conditions are presented in Table 7. Significant positive and negative SCA effects were found for all studied traits, except plant height at normal condition.

Table (6): Estimates of general combining ability (GCA) effects of parents for wheat traits under normal irrigation and drought conditions.

Trait / Parent	Days to heading		Days to maturity		Flag leaf area, cm^2		Plant height, cm	
	Normal	Drought	Normal	drought	Normal	Drought	Normal	drought
Giza-168 (P1)	-1.295	-1.105	-1.286	-1.562	-3.041	-2.970	1.590	2.038
Sakha-8 (P2)	0.610	0.467	0.524	0.533	-0.841	-2.012	-3.076	-3.581
Sakha-61 (P3)	-1.295	-1.248	-1.476	-1.038	5.245	5.978	-0.267	-0.200
Sakha-93 (P4)	-0.914	-0.771	0.143	0.343	0.640	2.397	-2.171	-2.486
Gemmeiza-9 (P5)	2.895	2.657	2.095	1.724	-2.003	-3.393	3.924	4.229
S.E. (g_i)[1]	0.120	0.112	0.100	0.100	0.158	0.167	0.488	0.418
LSD(g_i-g_j)[2] 5%	0.525	0.491	0.441	0.439	0.691	0.733	2.140	1.835
1%	0.870	0.815	0.732	0.727	1.146	1.215	3.550	3.043

Table (6): Continued

Trait / Parent	No. of spikes/plant		No. of kernels/spike		100-kernel weight, gm		Grain yield/plant, gm	
	Normal	Drought	Normal	drought	Normal	Drought	Normal	Drought
Giza-168 (P1)	-0.038	0.000	0.829	1.162	0.107	0.077	1.216	1.481
Sakha-8 (P2)	-0.229	-1.143	-2.314	-2.505	-0.216	-0.119	-1.655	-0.229
Sakha-61 (P3)	0.724	0.571	-1.981	-1.933	-0.143	-0.153	-0.631	-1.362
Sakha-93 (P4)	-0.086	-0.095	-0.648	-0.219	0.182	0.166	0.150	-0.429
Gemmeiza-9 (P5)	-0.371	-0.333	4.114	3.495	0.069	0.030	0.921	0.538
S.E. (g_i)[1]	0.095	0.105	0.170	0.169	0.003	0.028	0.083	0.136
LSD(g_i-g_j)[2] 0.05	0.411	0.447	0.744	0.741	0.028	0.128	0.364	0.597
0.01	0.681	0.741	1.234	1.229	0.046	0.212	0.603	0.990

[1] Standard error for a GCA effect.
[2] Least significant difference for the difference between estimates of GCA effects.

Based on SCA estimates, it could be concluded that the best combinations for days to heading (for earliness) were Giza-168 × Gemmeiza-9, Sakha-61 × Gemmeiza-9 and Giza-168 × Sakha-8 at normal condition, and Sakha61×Sakha-93 at drought condition; for days to maturity (for earliness) were Sakha-8 × Gemmeiza-9 at normal condition, and Sakha-61 × Gemmeiza-9 at drought condition; for flag leaf area were Giza-168 × Sakha-61, Sakha-8 × Gemmeiza-9 and Sakha-93 × Gemmeiza-9 at both conditions; for plant height was Sakha-61 × Sakha-93 (for plant shortness) at drought condition; for no. of spikes per plant were Sakha-8 × Gemmeiza-9, Sakha-8 × Sakha-61 and Sakha-61 × Sakha-93 at both conditions; for no. of kernels/spike were Sakha-8 × Gemmeiza-9, Giza-168 × Sakha-61 and Giza-168 × Sakha-93 at both conditions; for 100-kernel weight were Sakha-61 × Sakha-93 and Giza-168 × Gemmeiza-9 at both conditions; for grain yield per plant were Sakha-93 × Gemmeiza-9, Sakha-61 × Gemmeiza-9 and Sakha-61×Sakha-93 at both irrigation and drought conditions. These crosses could be selected and used in breeding programs to improving these traits or using it for direct cultivation as superior hybrids.

It is worthy to note that most of superior F_1 crosses in their SCA effects for grain yield and most of yield components traits include at least one of their parents of high GCA effects for the same traits. These results are in general agreement with those previously reported by Afiah (1999), Mohamed (2004), El-Danasory (2005), Sultan, *et al.* (2006) and Salama (2007).

Table (7): Estimates of specific combining ability (SCA) effects for F_1 crosses for some traits of wheat under normal irrigation and drought conditions.

Crosses / Trait	Days to heading		Days to maturity		Flag leaf area, cm^2		Plant height, cm	
	Normal	Drought	Normal	Drought	Normal	Drought	Normal	Drought
1- G. 168 x Skh. 8	-0.825	-0.095	-0.127	0.651	-1.916	3.029	1.175	1.587
2- G. 168 x Skh. 61	1.079	0.952	-0.460	-0.111	4.932	5.971	1.032	0.873
3- G. 168 x Skh. 93	-0.635	-0.524	-0.079	-0.159	0.937	-2.148	0.603	-1.841
4- G. 168 x Gem. 9	-1.111	-0.619	-0.032	0.127	-0.854	5.443	0.175	1.444
5- Skh. 8 x Skh. 61	1.175	0.714	0.397	0.127	-0.602	-1.886	0.365	-0.175
6- Skh. 8 x Skh. 93	-0.540	-0.095	-0.222	0.079	0.803	-0.238	0.270	-1.222
7- Skh. 8 x Gem. 9	-0.349	-0.524	-0.841	0.032	1.279	2.952	-0.159	1.397
8- Skh. 61 x Skh. 93	-0.635	-0.714	-0.222	0.651	-1.483	0.605	-0.206	-2.937
9- Skh. 61 x Gem. 9	-1.111	-0.476	-0.508	-0.730	-0.740	-0.871	-0.302	0.016
10- Skh. 93 x Gem. 9	0.508	0.381	0.206	0.222	1.232	2.076	-0.730	-0.032
S.E (Sij)[1]	0.308	0.289	0.259	0.259	0.406	0.431	1.259	1.079
LSD (Sij-Sik)[2] 0.05	1.047	0.982	0.880	0.882	1.375	1.464	4.271	3.660
0.01	1.505	1.411	1.264	1.268	1.976	2.103	6.136	5.259
LSD (Sij-Skl)[3] 0.05	0.955	0.896	0.803	0.803	1.258	1.337	3.897	3.341
0.01	1.372	1.287	1.154	1.154	1.807	1.921	5.600	4.800

Table (7): Continued

Crosses / Trait	No. of spikes/plant		No. of kernels/spike		100-kernel weight, gm		Grain yield/plant, gm	
	Normal	drought	Normal	Drought	Normal	Drought	Normal	Drought
1- G. 168 x Skh. 8	0.556	-0.190	0.619	0.254	0.040	-0.150	-0.292	0.092
2- G. 168 x Skh. 61	0.270	0.762	2.286	3.016	0.020	0.040	0.451	-0.008
3- G. 168 x Skh. 93	0.413	0.429	3.286	2.635	-0.024	-0.025	1.970	0.692
4- G. 168 x Gem. 9	0.698	0.333	0.190	0.921	0.129	0.221	2.132	0.059
5- Skh. 8 x Skh. 61	0.794	1.238	0.762	0.683	0.037	-0.017	1.589	0.268
6- Skh. 8 x Skh. 93	0.270	-0.095	-0.905	-0.698	0.006	-0.109	0.641	0.168
7- Skh. 8 x Gem. 9	0.889	1.143	2.667	3.254	0.162	0.050	1.037	-0.132
8- Skh. 61 x Skh. 93	0.651	1.190	0.429	-0.270	0.256	0.268	0.617	1.035
9- Skh. 61 x Gem. 9	0.603	0.429	-1.667	-2.317	-0.081	-0.196	0.879	1.302
10- Skh. 93 x Gem. 9	0.413	0.095	-1.000	-0.365	0.148	0.155	1.365	2.168
S.E (Sij)[1]	0.243	0.265	0.438	0.437	0.014	0.074	0.214	0.352
LSD (Sij-Sik)[2] 0.05	0.821	0.898	1.488	1.482	0.050	0.251	0.726	1.194
0.01	1.180	1.290	2.139	2.129	0.072	0.361	1.043	1.716
LSD (Sij-Skl)[3] 0.05	0.751	0.821	1.357	1.353	0.050	0.231	0.663	1.090
0.01	1.079	1.180	1.950	1.944	0.072	0.332	0.952	1.567

[1] Standard error for a SCA effect.

[2] Least significant difference for the difference between two SCA effects for a common parent.

[3] Least significant difference for the difference between two SCA effects for a non-common parent.

Results presented in Table (8) indicated that the *major assumptions* postulated for diallel analysis appeared to be valid for all traits at both studied conditions, except days to heading at normal condition. Accordingly, this trait, which had significant t^2 value, was removed and its genetic components and parameters were not estimated.

As in table 8, the regression coefficients were significantly different from zero for all studied traits, except spikes number/plant at drought stress condition and grain yield/plant at normal condition. Also, the regression coefficients were significantly different from unity for all studied traits, except days to maturity at both conditions and 100-kernel weight at normal condition.

Table (8): Values of t^2 regression coefficient of covariance (Wr) on variance (Vr) and t value for b=0 and b=1.

Trait	Cond.	t^2	Regression coefficient	t value for b=0	t value for b=1
Days to heading	N	7.152**	1.16±0.07	61.602	-2.342
	S	6.033	1.16±0.07	15.615	-2.139
Days to maturity	N	0.087	1.01±0.09	11.874	-0.124
	S	0.153	1.02±0.10	10.036	-0.186
Flag Leaf Area	N	0.903	0.82±0.14	5.949	1.350
	S	1.671	0.69±0.16	4.195	1.922
Plant height	N	5.391	1.16±0.08	14.440	-2.000
	S	3.895	0.81±0.08	9.845	2.367
No.of spikes/plant	N	0.858	0.85±0.12	7.241	1.255
	S	1.057	0.04±0.30	0.123	3.158
No.of kernels/spike	N	3.759	1.18±0.11	10.435	-1.574
	S	7.454	1.26±0.12	10.599	-2.203
100-kernel weight	N	0.0001	0.93±0.19	4.941	0.399
	S	1.050	0.76±0.16	4.906	1.515
Grain yield plant	N	0.043	0.36±0.42	0.868	1.529
	S	0.346	0.59±0.28	2.096	1.449

b=0 and b=1 indicate difference of regression coefficient values from 0 and 1, respectively.
***, ** = significant at 0.05 and 0.01 probability levels, respectively.**

Both additive (D) and dominance (H_1 and H_2) gene effects, as presented in Table (9), were significant for most traits at both conditions, except additive gene effects for spikes number/plant at drought stress condition, dominance gene effects (H_1 and H_2) for days to maturity, flag leaf area and plant height at normal condition.

The additive gene effects were more important than dominance for all traits at normal and drought stress conditions, except spikes number/plant at both conditions, 100-kernel weight at drought stress condition and grain yield/plant at normal condition.

The dominance effect (h^2), were highly significant for all traits at both conditions, except days to heading, days to maturity and 100-kernel weight at drought stress condition, flag leaf area at normal condition and plant height at both conditions. The observed positive and significant dominance effect values indicated that the dominant genes of these characters were due to heterozygosity and dominance seemed to be acting in positive direction. On the contrary, the remaining dominance effect values were not significant.

The results showed that the relative frequency of dominance and recessive alleles in parents under study revealed significantly negative (F) values for plant height at stress condition, indicating excess of recessive alleles among the parents. However, positive and significant or insignificant values were recorded for other traits at both studied conditions, indicating excess of dominant alleles in the parents.

Several ratios and proportions were obtained in Table 10. The mean degree of dominance $(H_1/D)^{1/2}$ is less than one for all traits under both water studied conditions, which confirms the role of partial dominance gene effects in controlling these traits, except grain yield/plant at normal condition, 100-kernel weight at drought stress condition and spikes number/plant at both conditions, which appeared to be controlled by over dominance gene effects.

Table (9): Estimates of genetic components of variance for the studied traits at both conditions

Characters	Cond.	D	F	H_1	H_2	h^2	E
Days to heading	N	-	-	-	-	-	-
	S	12.09** ±0.20	2.19** ±0.49	1.35* ±0.53	1.18* ±0.48	0.17±0.32	0.10±0.08
Days to maturity	N	8.85** ±0.09	0.504* ±0.23	0.46±0.25	0.49±0.23	0.76** ±0.15	0.12** ±0.038
	S	7.15** ±0.08	0.48* ±0.20	0.53* ±0.21	0.46* ±0.19	0.12±0.13	0.10** ±0.03
Flag leaf area	N	41.40** ±3.14	-0.04±7.83	15.12±8.50	14.50±7.70	2.77±5.19	0.36±1.28
	S	97.97** ±6.34	53.24** ±15.85	59.04** ±17.13	47.78** ±15.54	51.12** ±10.49	0.46±2.59
Plant height	N	41.00** ±0.70	13.20** ±1.74	2.07±1.70	0.81±1.71	-0.22±1.20	1.87** ±0.29
	S	29.96** ±0.91	-10.60** ±2.27	12.48** ±2.45	6.77** ±2.22	-0.72±1.50	1.63** ±0.37
No. of spikes/plant	N	0.69** ±0.10	0.007±0.25	2.17** ±0.27	2.18** ±0.25	7.05** ±0.17	0.11** ±0.05
	S	0.05±0.22	-0.30±0.56	3.16** ±0.61	2.87** ±0.55	6.48** ±0.37	0.14±0.09
No. of kernels/spike	N	31.38** ±.88	7.60** ±2.20	15.57** ±2.38	13.10** ±2.16	10.09** ±1.46	0.27±0.36
	S	23.77** ±1.09	2.28±2.71	17.92** ±2.93	15.27** ±2.66	11.46** ±1.80	0.34±0.44
100-kernel weight	N	0.11** ±0.01	-0.014±0.02	0.08** ±0.02	0.07** ±0.02	0.11** ±0.01	0.001±0.003
	S	0.04** ±0.01	-0.03±0.02	0.10** ±0.02	0.08** ±0.02	0.01±0.02	0.01±0.004
Grain yield plant	N	3.76** ±0.61	-2.10±1.53	10.02** ±1.66	9.65** ±0.51	24.81** ±1.01	0.10±0.25
	S	6.10** ±0.82	3.04±2.04	5.10* ±2.20	4.03** ±2.00	7.19** ±1.35	0.26±0.33

N= normal irrigation, S=Stress

***, ** = significant at 0.05 and 0.01 probability levels, respectively.**

The proportion of genes with positive and negative effects in parents $(H_2/4H_1)$ was nearly equal to the ratio 0.25 for days to maturity, no. of spikes/plant, no. of kernels/spike and 100-kernel weight at both conditions, flag leaf area and grain yield/plant at normal condition, and days number to heading at drought stress condition, indicating that the recessive and dominant alleles were equally distributed among the parents. The other traits at both conditions were not nearly equal to the ratio 0.25, indicating that the dominant and recessive alleles were unequally distributed among the parents. Furthermore, the ratio of dominant and recessive genes in the parents (K_D/K_R) was more than one for all traits at both conditions, suggesting the preponderance of dominance alleles. Except, 100-kernel weight at both conditions, plant height and spikes number/plant at drought stress condition and grain yield/plant at normal condition, which were less than one, showing an excess of recessive alleles among parents.

Heritability in broad sense ($h^2_{b.s}$) estimates had high values (0.88-0.99) for all studied traits at both studied water conditions, revealing that most of the phenotypic variability in these traits was due to genetic effects. Similar results were obtained by Sultan, *et al.* (2006) and Salama (2007) for these traits under normal and stress conditions. Heritability in narrow sense (h2n.s) estimates was moderate or high for all studied traits at both conditions, reflecting the role of additive gene action in governing these traits. Therefore, selection for these traits could be applied in early segregating generations, except spikes number/plant at both conditions, which had low values of heritability in narrow sense. These results are in general agreement with those previously reported by Mohamed (2004), Farhat (2005), Sultan, *et al.* (2006) and Salama (2007).

Table (10): Proportions of genetic components for the studied traits.

Characters	Cond.	$(H_1/D)^{1/2}$	$H_2/4H_1$	K_D/K_R	h^2(b.s)	h^2(n.s)
Days to heading	N	-	-	-	-	-
	S	0.34	0.22	1.74	0.98	0.93
Days to maturity	N	0.23	0.27	1.29	0.97	0.95
	S	0.27	0.22	1.28	0.97	0.94
Flag Leaf Area	N	0.60	0.24	1.00	0.99	0.84
	S	0.78	0.20	2.10	0.99	0.69
Plant height	N	0.23	0.10	6.08	0.89	0.88
	S	0.65	0.14	0.57	0.94	0.87
No. of spikes/plant	N	1.78	0.25	1.01	0.89	0.34
	S	8.10	0.23	0.44	0.88	0.27
No. of kernels/spike	N	0.70	0.21	1.42	0.98	0.79
	S	0.87	0.21	1.11	0.98	0.74
100-kernel weight	N	0.85	0.24	0.86	0.99	0.77
	S	1.60	0.21	0.56	0.90	0.61
Grain yield/plant	N	1.63	0.24	0.71	0.98	0.55
	S	0.91	0.20	1.75	0.92	0.62

N= Normal irrigation, S= Stress

REFERENCES

Afiah, S.A.N. (1999). Combining ability association and path coefficient analysis of some wheat (*T. aestivum, L.*) daillel crosses under desert conditions. Mansoura J. Agric.Res. 24.(4):1583-1596.

Ashoush, H.A, A.A.Hamada and I.H. Darwish (2001). Heterosis and combining ability in F_1 and F_2 diallel crosses of wheat (*Triticum aestivum* L.). J. Agric. Sci. Mansoura Univ. 26 (5) : 2579-2592.

Castelli, F; R. Contillo and F. Miceli (1996). Non-destructive determination of leaf chlorophyll content in four crop species. J. Agron. and Crop Sci., 177: 275-283.

El-Danasory, A.M.M. (2005). Studies on wheat breeding (*Triticum aestivum* L). M.sc. Thesis, Tanta Univ.

Farhat, W.Z.E.(2005). Genetical studies on drought tolerance in bread wheat (*Triticum aestivum* L). M.sc. Thesis, Tanta Univ.

Griffing, B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci. 9: 463-493.

Hayman, B.I. (1954). The theory and analysis of diallel crosses. Genetics, 39: 789 - 809.

Hayman, B.I. (1958). The separation of epistatic from additive and dominance variation in generation means. Heredity. 12: 371-390.

Jones, R.M. (1956). Analysis of variance of the half diallel tables. Heredity, 20: 117-121.

Mather, K. and J. L. Jinks (1982). Biometrical Genetics. 3rd ed. Chapman and Hall, London.

Mohamed, M.E.A. (2004). Genetical analysis and evaluation of drought tolerance trait under different conditions in wheat (*Triticum aestivum,* L). Ph.D. Thesis, Tanta Univ.

Salama, S.M. (2007). Gene action and heritability of diallel crosses in bread wheat (*Triticum aestivum,* L.) under various number of irrigations. J. Agric. Sci. Mansoura Univ., 32 (9): 7099-7109.

Salem, Nagwa R.A. and S.M. Abdel-Dayem (2006). Inheritance of some agronomic traits in wheat under drought conditions. . J. Agric. Sci. Mansoura Univ., 31 (11): 6867-6872.

Sultan, M.S, A.H.El-Hindi, A.E.Sharief, A.H.Abd El-latif and M.N.El-Hawary (2006). Genetic analysis of some bread wheat crosses under normal and water stress conditions. Egypt. J. Plant Breed. 10 (2) 249-265.

القدرة على التآلف والفعل الجينى وكفاءة التوريث لبعض هجن الداليل الـصنفيه فى قمح الخبز تحت ظروف الرى والجفاف

مأمون أحمد عبد المنعم
قسم المحاصيل- كلية الزراعة- جامعة المنصورة.

أجريت هذه الدراسة في المزرعة البحثية لقسم المحاصيل التابعة بمحطة التجارب والبحوث الزراعـة - كلية الزراعة – جامعة المنصورة -محافظـة الدقهليـة خـلال الموسـمين الـشتويين ٢٠٠٥/٢٠٠٦ و ٢٠٠٦/٢٠٠٧ و قد استخدمت خمسة أصناف من قمح الخبز مختلفة في صفاتها الوراثية كآباء. أجريت كل التهجينات الممكنة بين الآباء للحصول علي ١٠ هجن فيما عدا الهجن العكسية فـي الموسـم الأول ، وفـي الموسم الثانى تم زراعة الخمسة آباء و ١٠ هجن في تجربتين بنظام القطاعات الكاملـة العـشوائية تحـت الظروف الطبيعية (٥ ريات بالموسم) وظروف الجفاف (منع الرى بعد رية المحاياه) ، وذلك لدراسة القـدرة على التآلف والفعل الجينى وكفاءة التوريث لهذه الهجن تحت ظروف الرى العادى والجفاف ، وفيمـا يلـي ملخص لأهم النتائج:

١-أشارت النتائج إلي أن متوسطات مربعات التباين الراجع إلي التراكيب الوراثية و القدرة العامة و القـدرة الخاصة علي التالف كانت معنوية لكل الصفات تحت الظروف الطبيعية وظروف الجفاف ماعـدا القـدرة الخاصة علي التالف لصفة إرتفاع النبات تحت ظروف الرى العادى.

٢-كان الصنف سخا٦١ أفضل الآباء قدرة عامة على التآلف لصفات عدد الأيام حتى الطرد وعدد الأيام حتى النضج (التبكير فى النضج) ومساحة ورقة العلم و عدد السنابل/نبات تحت الظروف العاديـة والجفـاف ، والصنفين سخا ٨ و سخا٩٣ لصفة قصر النبات ، الصنفين جيزة ١٦٨ وجميزة ٩ لصفات عدد الحبـوب بالسنبلة ووزن ١٠٠ حبة ومحصول الحبوب/نبات تحت الظروف العادية والجفاف. أما بالنـسبة للهجـن فكانت أفضل الهجن قدرة خاصة على التآلف تحت ظروف الرى والجفاف الهجين سخا ٦١ X جميـزة ٩ للتبكير فى النضج ، جيزة ١٦٨ X سخا ٦١ لزيادة مساحة ورقة العلم ووزن الـ١٠٠حبة ، سـخا ٨ X جميزة ٩ لصفات عدد السنابل/نبات وعدد الحبوب بالسنبلة ، والهجين سـخا ٩٣ X جميـزة ٩ لـصفة محصول الحبوب/نبات تحت ظروف الجفاف ، هذه الهجن يمكن انتخابها واستخدامها فى برامج التربيـة لتحسين تلك الصفات تحت ظروف الجفاف.

٣-أظهرت النتائج أهمية كل من الفعل الجيني المضيف والسيادي في وراثة معظم الصفات المدروسة تحـت الظروف الطبيعية وظروف الجفاف. وقد لوحظ أن السيادة الغير تامة تتحكم في وراثـة كـل الـصفات المدروسة تحت الظروف الطبيعية وظروف الجفاف ماعدا محصول الحبوب/نبات تحت الظروف الطبيعية , وزن ١٠٠ حبة تحت ظروف الجفاف و عدد السنابل/نبات تحت ظروف الرى والجفـاف حيـث كـان المتحكم فيها السيادة الفائقة.

٤-كانت كفاءة التوريث بمعناها الضيق مرتفعة أو متوسطة لكل الصفات المدروسة تحـت ظـروف الـري والجفاف وهذا يعكس أهمية الفعل الجيني الإضافي في وراثة هذه الصفات ، ما عدا صفة عـدد الـسنابل لكل نبات تحت الظروف العادية والجفاف حيث كانت قيم نسبة التوريث بمعناها الضيق منخفضة.

توصي الدراسة باستخدام الصنف سخا ٦١ ، جيزة ١٦٨ و جميزة ٩ في برامج التربية لتحمـل الجفاف حيث كان لهما قدرة عامة علي التالف لمعظم الصفات تحـت الدراسـة. كـذلك توصـي الدراسـة بالانتخاب لصفات عدد الأيام حتى الطرد , عدد الأيام حتى النضج , مساحة ورقة العلم , طول النبات وعـدد الحبوب بالسنبلة تحت الظروف الطبيعية وظروف الجفاف ولصفة محصول الحبوب/نبـات تحـت ظـروف الجفاف في الأجيال الانعزالية المبكرة .