The 9th Plant Breeding international Conference September 2015 *Egypt. J. Plant Breed. 19 (5):87- 101. 2015 Special Issue*

HETEROSIS, COMBINING ABILITY ANALYSIS FOR BREAD WHEAT UNDER STRESS AND NORMAL IRRIGATION TREATMENTS

A.A. El-Hosary, S.A. Sedhom, M.K. Khlifa and K. A. Bayoumi

Agronomy. Dep, Fac. of Agric, Moshtohor, Egypt

ABSTRACT

Drought is one of the major environmental factors which threaten wheat production worldwide. Nine bread wheat genotypes were crossed in a 9x9 half diallel scheme in 2012/2013. The nine parents Yakora (P1), Sakha 93 (P2), Misr 2 (P3), Sids12 (P4), Gemmiza 11 (P5), Line 150 (P6), Line 116 (P7), Line 145 (P8) and Line 124 (P9) and their thirty-six F1 crosses were evaluated under normal and stress conditions during 2013/2014 in two experiments in a randomized complete block design (RCBD) with three replications at the Experiment Research Station of Moshtohor, Benha University, Kalubia Governorate, Egypt. The results of analysis of variance showed significant for all studied traits. Mean squares for genotypes, parents, crosses and parents vs. crosses were significant for all traits except days to heading for parent's mean squares. The highest mean values were detected under combined analysis by parents P5, P7,P1,P4,P4 and p8 for days to heading, plant height, no. of spike/plant, 1000 grain weight, no. of kernels/spike and grain yield, respectively. While, the highest mean values were recorded under combined analysis with crosses P1×P7, P3×P7, P1×P3, P5×P8, P4×P9 and P4×P5 for days to heading, plant height, no. of spike/plant, 1000 grain weight, no. of kernels/spike and grain yield, respectively. Mean squares of both general (GCA) and specific (SCA) combining ability estimates were highly significant for all the studied traits. The ratio of GCA/SCA being more than unity in all cases indicated that the additive gene effects were more important for all of the traits. P8 was a good combiner for days to heading and grain yield. The highest desirable SCA effects were obtained with P6×P8 for days to heading, P1×P4 for plant height and 1000 grain weight, P1×P5 for no. of spike/plant, P1×P3 for no. of kernels/spike, P1×P7 for grain yield under combined analyses. P4 was high tolerant for stress irrigation, for grain yield. The cross P2×P4 had high tolerance to stress irrigation treatment for this trait.

Key words: *Wheat, combining ability, drought, GCA and SCA.*

INTRODUCTION

Wheat (*Triticum aestivum L.*) is one of the most important and strategic cereal crops in the world. It is grown on about 200 million ha in a range of environments, with annual production of more than 600 million metric tons. Increasing wheat production to narrowing the gap between production and consumption is vital in Egypt. Big variation in wheat productivity in different parts of the country should be reduced to achieve a projected high productivity, through diversification of wheat breeding programs and developing new set of wheat varieties with high yielding.

Water stress is a problem that affects 45% of the world’s geographic area and is a major constraint in wheat production and the most important contributor to yield reduction in semiarid regions (Andrew *et al*. 2000; Amjad *et* *al.* 2011). Improving drought resistance is, therefore, a major objective in plant breeding programs.

Drought avoidance consists of mechanisms that reduce water loss from the plant and the mechanisms that maintain water uptake. Drought tolerance refers to the ability of the plant to withstand with low tissue water potentials.

Heterosis is a complex phenomenon, which depends on the balance of different combinations of gene effects as well as on the distribution of plus and minus alleles in the parents of a mating system. In self-pollinated crops, like wheat, the scope for utilization of heterosis depends mainly upon the direction and magnitude of heterosis. Heterosis over better parent may be useful in identifying the best crosses but these hybrids can be of immense practical value if they involve the best cultivars of the area (Prasad *et al* 1998).

According to Arunachalam (1976), Baker (1978), Esmail (2002), Joshi *et al* (2004), Hasnain *et al* (2006) and Farooq *et al* (2010), the combining ability is a most reliable biometrical tool to circumvent plant breeding programs.

In general, screening and discovering drought tolerant gene resources are urgently needed for creating productive breeding materials with improved drought tolerance. Diallel cross technique is a good tool for the identification of hybrid combination that have the maximum improvement and identifying superior lines among the progenies in early segregations.

Therefore, the major objectives of this work were:

1- Evaluating performance of nine parents of bread wheat and their F_1 crosses to identify the best performing genotypes.
2- Estimating heterosis, general and specific combining ability to identify the best combiner parents and its crosses for grain yield and its components

MATERIALS AND METHODS

Five commercial cultivars and four introduced lines of bread wheat were selected for this study. The parental Names, origin and pedigree of these genotypes are presented in Table (1). The experimental field work was carried out at Agricultural Research Station, of Moshtohor, Benha University, Kalubia Governorate, Egypt during the two successive seasons 2012/2013 and 2013/2014. The parents were crossed in a 9x9 diallel cross excluding reciprocals in 2012/2013 growing season. In 2013/2014 two adjacent experiments using randomized complete block design with three replications were carried out. Each experiment contained the nine parents and their resulting 36 F1's. The sowing date was on 24th Nov. 2013. The first experiment was irrigated only once after planting irrigation and the second one was normally irrigated. Plots of parents and F1's consisted of one rows, 3 m long, with spacing of 30 cm between rows and 20 cm between plants.

Table 1. Names, pedigree and origin of the parental genotypes

No	Name	Origin	Pedigree
P1	Yakora	Egypt	Ciano 67/Sonora 6411 Klien Rendidor/3/1L815626Y-2M-1Y-0M-302M
P2	Sakha 93	Egypt	S 92/TR 810328 S8871-1S-2S-1S-0S
P3	Misr 2	Egypt	SUPER-KAUZ/BAVIACORA-92[3589][3686]
P4	Sids 12	Egypt	BUC//7C/ALD/5/MAYA74/ON//1160.147/3/BB/GLL/4/ CHAT"S"/6/MAYA/VUL//CMH74A.630/4*SX **SD7096-4SD-1SD-1SD 0SD**
P5	Gemmiza 11	Egypt	BOW"S"/KVZ"S"//7C/SER182/3/GIZA 168/SAKHA61. GM7892-2GM-1GM-2GM-1GM-0GM.
P6	Line 150	CIMMYT	CMH.S87.150\ ELVIRA
P7	Line 116	CIMMYT	MILAN \ S7116 \\ Hall //(Ne700011)
P8	Line 145	CIMMYT	MILAN \ S7145 \\ OAPYMex
P9	Line 124	CIMMYT	MILAN \ S87124 \\ BABAX

The dry method of planting was used in this concern. The other cultural practices of growing wheat were practiced. The amount of total rainfall during the growing season were recorded in Table (2).

Table 2. Monthly averages of temperature, relative humidity and total rain fall during 2013/2014 season at Kalubia (Moshtohor).

Months	Temperature C		R.H. (%)	Rain fall mm/month
	Min.	Max.		
Nov.2013	27.1	14.6	51.6	0.2
Dec.2013	20.1	8.5	54.7	0.7
Jan.2014	19.7	7	55.8	1.2
Feb.2014	22.4	8.4	46.2	0.4
Mar.2014	27.8	11.0	37.3	0.1
Apr.2014	29.1	12.4	38.9	0.2
May.2014	35.5	18.0	32.1	----

Ten guarded plants from parents and the F1's were selected randomly from each plot for recording observations on different characters, namely, The characters studied were, Days to heading, Plant height(cm), grain yield/ plant (g), No .of spikes /plant, No .of kernels/ spike and 1000- kernel weight (g). A stress susceptibility index (s) was used to characterize relative sterss resistance of all genotypes. For each genotype drought susceptibility index (DSI) was calculated using formula given by **Saulescu *et al.* (1995)**

DSI = S/NS

Where: Ns and S character with normal irrigated and stress conditions, respectively.

Heterosis for each trait computed as parents vs. hybrids sum of squares was obtained by partitioning the genotypes sum of square to its components. Analysis of variance was conducted as outlined by Steel and Torrie (1980) for all the characters. The analysis of GCA and SCA was done following the procedure given by Griffing (1956) using Method II Model I. The combined analysis of the two experiments was carried out whenever homogeneity of mean squares was detected (Gomez and Gomez 1984). Percentages of heterosis relative to mid (MP) and better (BP) parents were calculated according to Fonsecca and Patterson (1968) as follows:

MP= (value of F1- mean of the two parents/mean of the two parents)×100.

BP= (value of F1- value of the best parent/value of the best parent)×100.

Analysis of variance was done using the computerized statistical program MSTAT-C.

RESULTS AND DISCUSSION

Analysis of variance

Mean squares of the analysis of variance for the studied traits of 45 wheat genotypes (9 parents and 36 F_1 hybrids) are presented in table (3), Results illustrated that irrigation mean squares were significant for all studied traits, indicating over all differences between normal and stress condition. Mean values of normal environment for all studied traits were higher than those of drought stress condition, except for 1000 grain weight. The increase in these traits are because of normal irrigation is prevailing favorable environment.

Mean squares for genotypes, parents, crosses and parents vs crosses were significant for all traits in both and across the two environments, except days to heading for parents mean squares, indicating wide diversity between the parents used in the present study for these traits.

Genotypes × irrigation were significant for all studied traits except, plant height and 1000 grain weight such results indicated that the tested genotypes varied from one to anther and ranked differently from normal to stress irrigation treatments.

Mean performance

Results in Table (4) showed the average of yield and its components traits at the combined across irrigation treatments. Its clear that the parental variety Gemmeiza 11 was earliness in heading. the parental variety Yakora (P1) gave the highest mean values for No. of spikes/ plant. Sids 12 (P4) exhibited the highest No. of kernels/ spike and 1000-grain weight. The parental inbred line

Table (3) Mean squares for yield and its components under normal irrigation and drought stress condition as well as the combined over them.

S.O.V.	Df	Days to heading	Plant height	no. of spike /plant	1000 kernal weight	no. of kernels /spike	Grain yield / plant
drought environment							
Rep/ I	2	11.92*	433.13**	0.36	65.71**	45.12	2.17
Genotypes (G)	44	10.37**	188.92**	68.82**	54.67**	541.32**	259.14**
Parent (P)	8	1.06	220.25**	169.51**	80.97**	1328.73**	286.91**
Cross (C)	35	12.12**	154.16**	43.42**	40.79**	362.55**	216.55**
P vs C.	1	23.65**	1154.86**	152.32**	330.18**	498.82**	1527.76**
Error	88	1.84	22.01	4.91	7.95	25.04	8.88
GCA	8	3.69**	247.53**	81.05**	63.85**	674.41**	190.83**
SCA	36	3.41**	21.96**	10.03**	8.09**	70.67**	63.17**
Error	88	0.61	7.34	1.64	2.65	8.35	2.96
GCA/SCA		1.08	11.27	8.08	7.9	9.54	3.02
Normal environment							
Rep/ I	2	1.45	238.23**	13.79	39.15*	32.45	1.34
Genotypes (G)	44	2.35**	176.93**	75.29**	71.56**	577.84**	283.95**
Parent (P)	8	2.26	232.23**	159.34**	102.23**	856.90**	347.70**
Cross (C)	35	2.43**	152.08**	57.90**	50.74**	528.00**	250.11**
P vs C.	1	0.15	604.20**	11.56	554.87**	89.63	958.27**
Error	88	1.29	22.08	4.07	7.24	27.15	8.79
GCA	8	0.87*	257.80**	70.88**	69.73**	792.28**	118.71**
SCA	36	0.76**	14.79**	14.92**	13.66**	59.35**	89.30**
Error	88	0.43	7.36	1.36	2.41	9.05	2.93
GCA/SCA		1.14	17.43	4.75	5.1	13.35	1.33
Combined analysis							
Irrigation (I)	1	1068.03**	455.00**	845.53**	6220.80**	488.35**	11891.05**
Rep/ I	4	6.69**	335.68**	7.08	38.79	52.43**	1.75
Genotypes (G)	44	6.26**	359.03**	125.15**	1036.93**	118.25**	415.33**
Parent (P)	8	1.42	440.66**	323.39**	2004.08**	173.43**	589.36**
Cross (C)	35	7.26**	301.63**	79.87**	831.04**	84.14**	317.33**
P vs C.	1	10.01*	1714.86*	123.90*	505.67*	870.55*	2452.97*
G x I	44	6.47**	6.82	18.97**	82.22**	7.99	127.76**
p2 x I	8	1.91	11.82	5.46	181.55**	9.78	45.25**
C x I	35	7.30**	4.6	21.45**	59.51**	7.39	149.33**
P.vs.C x I	1	13.78*	44.21	39.98*	82.78	14.5	33.05
Error	176	1.56	22.05	4.49	26.09	7.59	8.84
GCA	8	2.11**	504.59**	149.66**	1437.21**	129.10**	258.49**
SCA	36	2.08**	34.14**	17.73**	103.07**	19.49**	111.76**
GCA x L	8	2.46**	0.74	2.27	29.48**	4.48	51.05**
SCA x L	36	2.09**	2.61	7.22**	26.95**	2.26	40.71**
Error	176	0.52	7.35	1.5	8.7	2.53	2.95
GCA/SCA		1.01	14.78	8.44	13.94	6.63	2.31
GCA x L/GCA		1.17	0	0.02	0.02	0.03	0.2
SCA x L/SCA		1.00	0.08	0.41	0.26	0.12	0.36

* $p < 0.05$; ** $p < 0.01$

Table 4. Mean performance of the genotypes for yield and its components over the studied environments .

Traits	Days to heading	**Plant height**	**No. of spike /plant**	**No. of kernels/ spike**	**1000 kernel weight**	**Grain yield/ plant**		
						D	N	C
yakora (p1)	**93.33**	81.67	37.33	50.00	37.83	43.07	54.00	48.53
Sakha 93 (p2)	**93.67**	93.83	32.83	53.33	39.87	44.07	61.07	52.57
Misr 2 (p3)	**93.83**	107.37	29.17	59.00	41.04	59.60	65.53	62.57
Sids 12(p4)	**93.50**	97.80	12.17	111.83	53.63	49.80	53.47	51.63
Gemmeiza11(P5)	**92.50**	106.40	22.67	66.33	48.37	45.40	62.60	54.00
L 150 (p6)	**92.67**	106.10	25.50	73.83	42.13	58.93	70.27	64.60
L 116 (P7)	**93.83**	107.90	22.50	69.83	45.33	57.75	63.67	60.71
L 145 (P8)	**93.17**	104.13	31.67	64.17	40.87	73.60	88.67	81.13
L 124 (P9)	**93.00**	100.50	24.83	59.17	50.47	55.27	73.27	64.27
1x2	**93.83**	86.17	28.00	63.00	42.08	45.47	63.80	54.63
1x3	**91.83**	96.48	29.33	71.83	40.64	70.02	70.47	70.24
1x4	**93.17**	102.37	20.43	90.50	49.33	62.20	67.40	64.80
1x5	**92.83**	96.40	31.67	56.17	41.39	46.31	93.80	70.06
1x6	**92.67**	97.63	32.50	58.50	44.87	59.07	84.07	71.57
1x7	**91.33**	104.67	28.50	64.83	44.40	71.00	74.20	72.60
1x8	**92.83**	98.80	30.67	58.50	47.77	65.93	69.80	67.87
1x9	**91.50**	97.57	27.50	53.00	45.37	50.47	54.40	52.43
2x3	**92.00**	102.87	25.17	64.00	48.17	60.27	61.73	61.00
2x4	**92.00**	97.03	21.00	79.33	48.68	62.73	60.13	61.43
2x5	**93.50**	105.00	21.00	74.83	48.93	47.60	67.13	57.37
2x6	**92.50**	103.13	26.67	67.67	44.30	61.53	64.73	63.13
2x7	**92.17**	110.77	19.67	75.33	51.27	46.00	65.00	55.50
2x8	**92.50**	102.90	27.17	61.67	46.40	61.80	69.93	65.87
2x9	**91.50**	103.23	24.83	59.67	48.23	56.20	62.40	59.30
3x4	**92.50**	111.80	23.93	82.67	46.40	68.33	91.27	79.80
3x5	**92.33**	112.57	20.00	76.17	50.67	55.80	65.60	60.70
3x6	**91.67**	112.20	23.17	74.17	44.87	61.40	63.80	62.60
3x7	**92.83**	115.73	25.50	74.00	49.18	74.00	77.03	75.52
3x8	**91.33**	112.17	23.17	60.83	50.33	61.40	64.13	62.77
3x9	**93.50**	115.13	27.07	68.83	46.73	74.40	75.20	74.80
4x5	**92.50**	107.60	21.00	90.17	54.67	80.33	88.60	84.47
4x6	**93.17**	110.40	19.00	94.50	50.83	69.13	66.60	67.87
4x7	**91.83**	109.43	22.83	89.17	52.40	69.60	82.07	75.83
4x8	**96.33**	103.73	23.17	65.33	49.53	57.13	72.13	64.63
4x9	**92.50**	111.03	20.00	103.00	51.13	70.27	73.43	71.85
5x6	**92.50**	113.77	22.00	73.67	50.57	63.67	71.53	67.60
5x7	**91.67**	115.30	19.67	75.17	54.49	56.65	69.33	62.99
5x8	**94.50**	108.47	27.67	61.83	54.73	68.47	81.73	75.10
5x9	**92.17**	112.93	26.67	69.33	54.80	65.40	83.33	74.37
6x7	**94.00**	106.23	29.33	64.17	52.06	57.47	83.47	70.47
6x8	**94.00**	115.60	22.67	75.00	51.73	69.93	71.53	70.73
6x9	**92.67**	112.97	25.33	72.33	47.63	61.17	72.00	66.58
7x8	**95.00**	113.23	27.17	54.17	51.37	69.47	75.13	72.30
7x9	**93.50**	113.20	24.77	64.17	51.13	61.33	72.60	66.97
8x9	**94.00**	111.10	25.50	65.67	52.70	70.75	80.38	75.57
Mean of parents	93.28	100.63	26.52	67.50	44.39	54.16	65.84	60.00
Mean of crosses	92.80	106.93	24.83	70.92	48.88	62.57	72.50	67.54
Mean of Genotypes	92.89	105.67	25.16	70.24	47.98	60.89	71.17	66.03
LSD 5%	2.001	7.5144	3.391	0.438	0.438	4.83	4.81	4.76
LsD 1%	2.629	9.8753	4.4565	0.576	0.576	6.5	6.37	6.25

L116 expressed longest parent. The parental line L145 (P8) give the heaviest grain yield / plant at both and across of irrigation treatments.

The f1 crosses were generally earlier in heading, the earliest hybrids were P1xP7, P3xP8, P1xP3, P1xP9, P3xP6, P4xP7 and P5xP7.

For plant height, the F1 hybrids: P3xP7, P3xP9, P5xP7, P5xP6, P6xP8, P7xP8 and P7xP9 had the highest values. On the other hand, the hybrids: P1xP2, P1xP3, P1xP5, P1xP6, P1xP8, P1xP9 and P2xP4 had the lowest value. Some farmers usually prefer higher plant due to the high price of hay. On the other hand, this plant must be given high yield for grain and behave resistant to lodging

For No. of spikes/ plant, five hybrids P1xP3, P1xP5, P1xP6, P6xP7 and P1xP8 expressed the highest values for this trait. The F1 hybrid P4xP9 was the highest hybrid for No. of grains/ spike. As for 1000-grain weight, the three crosses P4xP5, P5xP7 P5xP8 and P5xP9 exhibited the highest weight.

The high yield grain/ plant was obtained by crosses P4xP5 in droght stress condition as well as the combined analysis on the other hand the cross P1xP5 ranked the first hybrid for this traits in normal irrigation. These hybrids could be attributed to its high No. of grains/ spike, grain weight/spike and 1000-grain weight. Therefore, these crosses could be efficient for prospective wheat breeding programs aiming at improving wheat grain yield.

Heterotic effects

Percentages of heterosis relative to mid (MP) and better (BP) parents in studied wheat crosses in the combined analysis are presented in Table(5). The f1 cross 3×8 and 1×7 showed significant negative heterosis effect for days to heading by (-2.40%) under combined analysis. Values of heterosis percentage relative to (MP) were significantly positive in eighteen , three , nine , seventeen and nineteen crosses with range of 6.35-14.08, 20.57-31.73, 11.84-31.80, 10.92-24.66 and 7.17-59.29% for plant height, No. of spikes/ plant, No. of kernels/ spike, 1000-grain weight and grain yield/ plant, respectively (Table 7). However, heterosis percentage relative to (BP) were significantly positive in ten , five , twelve and fifteen crosses with range of 6.14-10.48, 12.81-21.75, 8.47-22.78 and 6.23-56.42% for plant height, No. of kernels/ spike, 1000-grain weight and grain yield/ plant, respectively. With respect to No. of spikes/plant one cross for each traits exhibited significantly positive heterosis compared to better parents .The f1 11 crosses were significant negative heterosis effect for days to heading by (-2.66 ، -1.95 %) relative to better parent .

Averages of heterosis percentages across all F_1 hybrids were preceded with a desirable sign, *i.e.* exhibiting on average a desirable heterosis relative to mid parent for all studied traits. Averages of all heterotic effects relative to better parent across all studied hybrids were preceded with a desirable sign, *i.e.* showing in average a desirable heterobeltiosis for all traits. Pronounced and

Table (5): Heterosis relative to mid and better parent for the studied traits in the combined analysis .

Cross	Days to heading		Plant height		Number of spike /plant		Number of kernels/spike		1000 kernal weight	
	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P	M.P	B.P
1x2	0.36	0.18	-1.80	-8.17**	-20.19**	-25.00**	21.94**	18.13**	8.30	5.54
1x3	-1.87	-2.13**	2.08	-10.14**	-11.78*	-21.43**	31.80**	21.75**	3.05	-0.97
1x4	-0.27	-0.36	14.08*	4.67	-17.44*	-45.27**	11.84*	-19.08**	7.87	-8.02**
1x5	-0.09	0.36	2.52	-9.40**	5.56	-13.64**	-3.44	-15.33**	-3.97	-14.43**
1x6	-0.36	-0.71	3.99	-7.98**	3.45	-12.95**	-5.52	-20.77**	12.21**	6.49
1x7	-2.40*	-2.66**	10.43*	-3.00	-4.74	-23.66**	8.21	-7.16	6.77	-2.06
1x8	-0.45	-0.54	6.35*	-5.12*	-11.11*	-17.86**	2.48	-8.83	21.39**	16.88**
1x9	-1.79	-1.96*	7.12*	-2.92	-11.53*	-26.34**	-2.90	-10.42*	2.76	-10.11**
2x3	-1.87	-1.95*	2.25	-4.19	-18.82**	-23.35**	13.95	8.47	19.06**	17.36**
2x4	-1.69	-1.78*	1.27	-0.78	-6.67	-36.04**	-3.94	-29.06**	4.12	-9.24**
2x5	0.45	-0.18	4.88	-1.32	-24.32**	-36.04**	25.07**	12.81**	10.92*	1.17
2x6	-0.72	-1.25	3.17	-2.80	-8.57	-18.78**	6.42	-8.35*	8.05	5.14
2x7	-1.69	-1.78*	9.81*	2.66	-28.92**	-40.10**	22.33**	7.88	20.34**	13.09**
2x8	-0.98	-1.25	3.96	-1.18	-15.76**	-17.26**	4.96	-3.90	14.95**	13.54**
2x9	-1.96	-2.31**	6.24	2.72	-13.87*	-24.37**	6.07	0.85	6.79	-4.43
3x4	-1.25	-1.42	8.98*	4.13	15.81	-17.94**	-3.22	-26.08**	-1.98	-13.49**
3x5	-0.89	-1.60*	5.32	4.84	-22.83**	-31.43**	21.54**	14.82**	13.34**	4.76
3x6	-1.70	-2.31**	5.12	4.50	-15.24*	-20.57**	11.67	0.45	7.88	6.49
3x7	-1.07	-1.07	7.53*	7.26**	-1.29	-12.57**	14.88*	5.97	13.86**	8.47*
3x8	-2.32*	-2.66**	6.07	4.47	-23.84**	-26.84**	-1.22	-5.19	22.90**	22.64**
3x9	0.09	-0.36	10.78**	7.23**	0.25	-7.20	16.50*	16.34**	2.14	-7.40*
4x5	-0.54	-1.07	5.39	1.13	20.57*	-7.35	1.22	-19.37**	7.19	1.93
4x6	0.09	-0.36	8.29*	4.05	0.88	-25.49**	1.80	-15.50**	6.16	-5.22
4x7	-1.96	-2.13**	6.40*	1.42	31.73**	1.48	-1.83	-20.27**	5.89	-2.30
4x8	3.21**	3.03**	2.74	-0.38	5.70	-26.84**	-25.76**	-41.58**	4.83	-7.64**
4x9	-0.80	-1.07	11.99**	10.48**	8.11	-19.46**	20.47**	-7.90**	-1.76	-4.66
5x6	-0.09	-0.18	7.07*	6.92**	-8.65	-13.73**	5.11	-0.23	11.75*	4.55
5x7	-1.61	-2.31**	7.61*	6.86**	-12.92	-13.24*	10.40	7.64	16.31**	12.66**
5x8	1.80	1.43	3.04	1.94	1.84	-12.63**	-5.24	-6.78	22.67**	13.16**
5x9	-0.63	-0.90	9.17*	6.14*	12.28	7.38	10.49	4.52	10.89*	8.59**
6x7	0.80	0.18	-0.72	-1.54	22.22**	15.03**	-10.67	-13.09**	19.04**	14.83**
6x8	1.17	0.89	9.97**	8.95**	-20.70**	-28.42**	8.70	1.58	24.66**	22.78**
6x9	-0.18	-0.36	9.36*	6.47*	0.66	-0.65	8.77	-2.03	2.88	-5.61
7x8	1.60	1.24	6.81	4.94*	0.31	-14.21**	-19.15**	-22.43**	19.18**	13.31**
7x9	0.09	-1.58*	8.64*	-0.03	4.65	-8.83*	-0.52	8.45	6.75	-0.45
8x9	0.98	0.89	8.58*	6.69*	-9.73	-19.47**	6.49	2.34	15.40**	4.43

* $p < 0.05$; ** $p < 0.01$

Table (5): cont.

cross	Grain yield					
	M.P			B.P		
	D	N	C	D	N	C
1x2	4.36	10.89*	8.08	3.18	4.48	3.93
1x3	36.40**	17.90**	26.45**	17.48**	7.53*	12.27**
1x4	33.96**	25.43**	29.38**	24.90**	24.81**	25.50**
1x5	4.69	60.89**	36.65**	2.00	49.84**	29.73**
1x6	15.82**	35.30**	26.52**	0.23	19.64**	10.78**
1x7	40.85**	26.12**	32.92**	22.94**	16.54**	19.59**
1x8	13.03**	-2.15	4.68	-10.42**	-21.28**	-16.35**
1x9	2.64	-14.51**	-7.03	-8.69	-25.75**	-18.41**
2x3	16.27**	-2.47	5.96	1.12	-5.80	-2.50
2x4	33.66**	5.01	17.91**	25.97**	-1.53	16.87**
2x5	6.41	8.57*	7.66	4.85	7.24	6.23*
2x6	19.48**	-1.42	7.77	4.41	-7.87*	-2.27
2x7	-9.64*	4.22	-2.01	-20.35**	2.09	-8.58**
2x8	5.04	-6.59*	-1.47	-16.03**	-21.13**	-18.82**
2x9	13.15**	-7.10	1.51	1.69	-14.83**	-7.73**
3x4	24.92**	53.39**	39.75**	14.65**	39.27**	27.54**
3x5	6.29	2.39	4.15	-6.38	0.10	-2.98
3x6	3.60	-6.04	-1.55	3.02	-9.20**	-3.10
3x7	26.12**	19.25**	22.52**	24.16**	17.55**	20.70**
3x8	-7.81*	-16.82**	-12.64**	-16.58**	-27.67**	-22.64**
3x9	29.54**	8.36*	17.95**	24.83**	2.64	16.39**
4x5	68.77**	52.67**	59.92**	61.31**	41.53**	56.42**
4x6	27.16**	7.65	16.78**	17.31**	-5.22	5.06
4x7	29.43**	40.13**	35.00**	20.52**	28.90**	24.91**
4x8	-7.40	1.50	-2.64	-22.37**	-18.65**	-20.34**
4x9	33.76**	15.89**	23.99**	27.14**	0.23	11.80**
5x6	22.04**	7.68*	14.00**	8.03	1.80	4.64
5x7	9.84*	9.82*	9.83*	-1.90	8.90*	3.76
5x8	15.07**	8.07*	11.15**	-6.97*	-7.82**	-7.44**
5x9	29.93**	22.67**	25.76**	18.34**	13.74**	15.72**
6x7	-1.50	24.64**	12.47**	-2.49	18.79**	9.08**
6x8	5.53	-9.98**	-2.93	-4.98	-19.32**	-12.82**
6x9	7.12	0.33	3.34	3.79	-1.73	3.07
7x8	5.77	-1.36	1.94	-5.62	-15.26**	-10.89**
7x9	8.54	6.04	7.17**	-11.71**	-3.37	-7.38**
8x9	9.81*	-0.72	3.95	-3.87	-9.34**	-6.86**

* $p< 0.05$; ** $p< 0.01$

favorable heterosis has been obtained by several researchers for wheat traits (Sadeque *et al* 1991, Krishna and Ahmad, 1992, Khan *et al* 1995, Munir *et al* 1999, Rasul *et al* 2002, Motawea, 2006, Dawwam *et al* 2007).

Combining ability

Mean squares of both general (GCA) and specific (SCA) combining ability estimates were highly significant for all the studied traits (Table 3). Thus, both additive and non-additive gene effects were important in controlling the inheritance of all the characters studied in both and across the two treatments.

The ratio of GCA/SCA being more than unity in all cases indicated that the additive gene effects were more important for all of the traits. In general, for all studied traits, the magnitude of mean squares due to GCA was much higher than that due to SCA. Suggested that selection based on phenotype could be effective to improve and develop wheat genotypes. The higher importance of GCA than SCA variance for studied traits was also reported by (Larik *et al* 1995, Chowdhry *et al* 1999, Sangwan *et al* 1999, Menshawy 2000, Joshi *et al* 2003, Koumber and EL-Beially, 2005, Abdel Nour, 2006, Salem and Abdel Dayem, 2006).

The interactions between each type of combining ability and irrigation treatment were significant for No. of grains/ spike, and grain yield /plant. It is fairly evident that the ratios for SCA x I/SCA was much higher than the ratios of GCA x I/GCA was detected. For No. of spikes / plant, the significant SCAxI along with insignificant GCAxI was detected. Such results indicated that non additive effects were much more influenced by environmental changes than GCA. El Hosary et al. (2009 a, b) found that non additive type of gene action was much more influence by the environmental condition than additive genetic ones for some drought measurements.

General Combing Ability (GCA) effects

Test of homogeneity revealed the validity of the combined analysis for the data of the two irrigation treatments. The general combining ability effects $\hat{g}_i$ of each parent for all studied measurements at the combined analysis are presented in Table (6). Such results are being used to compare the average performance of each parent with other genotype and facilitate selection of parents for further improvement to drought resistance. High positive values would be interest under all measurements. The varieties P1 (Yakora) and P2 (Sakha 93) had the highest significant $\hat{g}_i$ effects for No. of spikes/ plant. However, these parents gave significant undesirable or insignificant $\hat{g}_i$ effects for other traits. The parental variety P3 (Misr 2) expressed significant positive $\hat{g}_i$ effects for plant height in the combined analysis and grain yield/ plant in drought environment and combined analysis. However, it gave significant undesirable or insignificant $\hat{g}_i$ effects for other measurements. The parental variety P4 (Sids 12) showed significant positive $\hat{g}_i$ effects for No. of grains/ spike and 1000-grain weight in the combined analysis and grain yield/ plant under drought stress condition and the combined data. However, it gave significant undesirable or insignificant $\hat{g}_i$ effects for other measurements. The parental variety P5 (Gemmiza 11) had significant positive $\hat{g}_i$ effects for 1000-grain weight in the combined analysis as well as grain yield/plant under normal irrigation, while it expressed insignificant $\hat{g}_i$ effects for the most other traits. The parental line 150

(P6) expressed significant desirable $\hat{g}_i$ effects for plant height and No. of grains/ spike in the combined analysis and grain yield/ plant in drought stress

Table 6. Estimates of general combining ability effects for yield and its components at the combined analysis.

Parent	Days to heading	Plant height	Number of spike /plant	Number of kernels/spike	1000 kernal weight	Grain yield		
						D	N	C
g1	-0.21	-10.30**	4.69**	-7.82**	-4.39**	-4.76**	-2.34**	-3.55**
g2	-0.14	-5.27**	0.68*	-4.56**	-2.01**	-7.20**	-6.79**	-6.99**
g3	-0.30	3.36**	0.37	-1.08	-1.89**	3.26**	-1.03*	1.12*
g4	0.19	-0.70	-5.09**	19.63**	2.76**	2.76**	-0.28	1.24*
g5	-0.18	2.55**	-1.51**	0.69	2.47**	-3.08**	3.15**	0.03
g6	-0.04	2.49**	0.00	2.30**	-0.79	1.12*	0.60	0.86
g7	0.10	4.33**	-0.84*	-0.15	1.56**	1.10*	1.32**	1.21*
g8	0.72**	1.59*	1.71**	-6.46**	0.59	5.74**	4.59**	5.16**
g9	-0.14	1.95*	-0.03	-2.55**	1.71**	1.05*	0.78	0.92
L.S.D gi 0.05	0.40	1.51	0.68	1.64	0.89	0.96	0.96	0.96
L.S.D gi 0.0	0.53	1.98	0.89	2.15	1.16	1.27	1.26	1.25
L.S.D gi-gj 0.05	0.60	2.27	1.02	2.46	1.33	1.45	1.44	1.43
L.S.D gi-gj 0.01	0.79	2.97	1.34	3.23	1.74	1.90	1.89	1.88

*** $p< 0.05$; ** $p< 0.01$**

environment. Also, it gave either significant negative or insignificant $\hat{g}_i$ effects for other traits. The parental line 116 (P7) expressed significant desirable $\hat{g}_i$ effects for plant height, 1000-grain weigh and grain yield/ plant. Also, it gave either significant negative or insignificant $\hat{g}_i$ effects for other traits. The parental line 145 (P_8) expressed significant desirable $\hat{g}_i$ effects for days to heading, plant height, No. of spikes/ plant and grain yield/ plant. The P8 showed the best combiner for grain yield and its attributes. Also, it gave either significant negative or insignificant $\hat{g}_i$ effects for other traits. The parental line 124 (P_9) exhibited significant desirable $\hat{g}_i$ effects for plant height, 1000-grain weigh in the combined analysis as well as grain yield/ plant at drought stress condition. Also, it gave either significant negative or insignificant $\hat{g}_i$ effects for other traits.

Specific combining ability (SCA) effects

Specific combining ability effects $\hat{S}_{ij}$ of the F_1 crosses for the studied traits in the combined analysis are presented in (Table 7). The results showed that best SCA effects for plant height was obtained from the crosses $P_1 \times P_4$ (7.70), $P_1 \times P_7$ (4.96), $P_2 \times P_7$ (6.03) and $P_6 \times P_8$ (5.84). P1xP2, P1xP7, P3xP8, P4xP7, P4xP8 and P7xP8 for days to heading ; P1xP5, P1xP6, P3xP4, P4xP5, P4xP7, P5xP8, P5xP9 and 6x7 for No. of spikes/ plant; P1xP3, P1xP4, P2xP5, P2xP7, P3xP5, P4xP9 and P6xP8 for No. of kernels/ spike; P1xP4, P1xP8, P2xP3, P2xP7, P3xP8, P5xP8, P6xP7 and 6x8 for 1000-grain weight. For grain yield/ plant, sixteen, eleven and fourteen crosses exhibited positive and significant $\hat{S}_{ij}$ effects under drought stress condition, normal irrigation and combined analysis, respectively. The six crosses i.e. P1xP7, P3xP7, P3xP9, P4xP5, P4xP7 and

P5xP9 witch these crosses showed highly significant positive $\hat{S}_{ij}$ effects in both and across for grain yield/ plant.

Table 7. Estimates of specific combining ability effects for yield and its components 'at the combined analysis .

Traits	Days to heading	Plant height	Number of spike /plant	Number of kernels/spike	1000 kernal weight	Grain yield		
						D	N	C
P1xP2	1.29*	-3.94	-2.54*	5.15	0.49	-3.47*	1.76	-0.85
P1xP3	-0.56	-2.25	-0.89	10.50**	-1.06	10.62**	2.67	6.65**
P1xP4	0.29	7.70**	-4.34**	8.45**	2.98*	3.30*	-1.15	1.08
P1xP5	0.32	-1.53	3.32**	-6.94**	-4.67**	-6.74**	21.83**	7.54**
P1xP6	0.02	-0.23	2.64*	-6.22*	2.07	1.81	14.64**	8.23**
P1xP7	-1.45*	4.96*	-0.52	2.57	-0.75	13.77**	4.05*	8.91**
P1xP8	-0.57	1.83	-0.91	2.54	3.59*	4.06*	-3.61*	0.22
P1xP9	-1.04	0.25	-2.33*	-6.87*	0.07	-6.72**	-15.21**	-10.97**
P2xP3	-0.45	-0.90	-1.05	-0.59	4.08**	3.31*	-1.61	0.85
P2xP4	-0.94	-2.67	0.24	-5.97*	-0.07	6.28**	-3.96*	1.16
P2xP5	0.93	2.04	-3.34**	8.47**	0.49	-3.01	-0.39	-1.70
P2xP6	-0.21	0.24	0.82	-0.31	-0.89	6.72**	-0.25	3.24*
P2xP7	-0.68	6.03*	-5.34**	9.82**	3.73*	-8.79**	-0.70	-4.75**
P2xP8	-0.97	0.90	-0.40	2.45	-0.17	2.37	0.97	1.67
P2xP9	-1.10	0.88	-0.99	-3.46	0.54	1.45	-2.76	-0.66
P3xP4	-0.28	3.47	3.49**	-6.12*	-2.46	1.41	21.41**	11.41**
P3xP5	-0.09	0.98	-4.02**	6.32*	2.10	-5.27**	-7.68**	-6.48**
P3xP6	-0.89	0.68	-2.37*	2.71	-0.44	-3.87*	-6.93**	-5.40**
P3xP7	0.14	2.37	0.81	5.00	1.52	8.75**	5.58**	7.16**
P3xP8	-1.98**	1.54	-4.08**	-1.87	3.65*	-8.50**	-10.59**	-9.54**
P3xP9	1.05	4.15	1.56	2.22	-1.07	9.19**	4.28**	6.74**
P4xP5	-0.41	0.08	2.43*	-0.40	1.45	19.76**	14.57**	17.16**
P4xP6	0.12	2.94	-1.08	2.33	0.88	4.36**	-4.89**	-0.26
P4xP7	-1.35*	0.13	3.59**	-0.55	0.10	4.84**	9.86**	7.35**
P4xP8	2.53**	-2.83	1.37	-18.08**	-1.80	-12.27**	-3.34*	-7.80**
P4xP9	-0.44	4.11	-0.05	15.68**	-1.33	5.56**	1.76	3.66*
P5xP6	-0.18	3.05	-1.65	0.44	0.91	4.74**	-3.38*	0.68
P5xP7	-1.15	2.74	-3.15**	4.39	2.48	-2.26	-6.30**	-4.28**
P5xP8	1.06	-1.35	2.30*	-2.64	3.70*	4.91**	2.83	3.87*
P5xP9	-0.41	2.76	3.04**	0.95	2.64	6.54**	8.24**	7.39**
P6xP7	1.05	-6.26*	5.00**	-8.22**	3.31*	-5.64**	10.38**	2.37
P6xP8	0.43	5.84*	-4.21**	8.92**	3.95**	2.18	-4.82**	-1.32
P6xP9	-0.04	2.85	0.19	2.35	-1.27	-1.90	-0.55	-1.22
P7xP8	1.29*	1.64	1.12	-9.46**	1.24	1.73	-1.94	-0.10
P7xP9	0.65	1.25	0.47	-3.37	-0.12	-1.71	-0.67	-1.19
P8xP9	0.53	1.88	-1.35	4.44	2.42	3.07	3.85*	3.46*
LSD5% (sij)	1.29	4.83	2.18	5.26	2.84	3.10	3.08	3.06
LSD1% (sij)	1.70	6.37	2.88	6.93	3.74	4.07	4.06	4.03
LSD5% (sij-sik)	1.90	7.13	3.22	7.75	4.18	4.57	4.55	4.51
LSD1% (sij-sik)	2.50	9.39	4.24	10.22	5.51	6.01	5.98	5.95
LSD5% (sij-skL)	1.80	6.76	3.05	7.36	3.97	4.34	4.31	4.28
LSD1% (sij-skL)	2.37	8.91	4.02	9.70	5.23	5.70	5.67	5.64

* $p < 0.05$; ** $p < 0.01$

Drought susceptibility index (DSI)

Mean squares for drought susceptibility index (DSI) for all traits are presented in (table 8). Results indicated that mean squares for genotypes, parents, crosses and parent Vs crosses were significant for all traits.

Mean performance of the parents and their 36 hybrids for (DSI) are presented in (table 9). The parent Yakora (p1) was high tolerant for stress irrigation , for plant height, the parent line 116 (p7) for days to heading and plant height, the parent Sakha 93 (p2) for no. of spikes, the parent line 124 (p9) for days to heading and no. of kernels , the parent gemmeiza 11 (p5) for 1000 kernal weight , the parent sids 12 (p4) for days to heading and grain yield . For days to heading the crosses p5×p7, p3×p7, p3×p4, p3×p5, p3×p6, p3×p8, p4×p7, p4×p9, p5×p6 and p7×p8 had height tolerance to stress irrigation treatment for this trait. For plant height the seven crosses p1×p4, p1×p7, p2×p7, p3×p5, p3×p9, p4×p5 and p5×p6 had height tolerance to stress irrigation treatment for this trait. For no. of spikes the cross p2×p6 had heigh tolerance to stress irrigation treatment for this trait. For no. of kernels the cross p3×p9 had heigh tolerance to stress irrigation treatment for this trait. For 1000- kernel weight the cross p1×p5 had heigh tolerance to stress irrigation treatment for this trait. For grain yield the cross p2×p4 had heigh tolerance to stress irrigation treatment for this trait

Table (8) Mean squares of yield and yield component for susceptibility index (SI) under normal irrigation (N) and drought stress (D).

S.O.V.	d.f.	Days to heading	Plant height	Number of spike	Number of kernals	1000 kernal weight	Grain yield
Rep/L	2	0.0191**	0.0001	0.0063	0.0045	0.0012	0.0023
Genotypes	44	0.0034**	0.0012**	0.0404**	0.0270**	0.0097**	0.0369**
Parent	8	0.0025**	0.0020**	0.0175**	0.0710**	0.0126**	0.0195**
Cross	35	0.0030**	0.0008**	0.0441**	0.0162**	0.0085**	0.0404**
Par.vs.cr.	1	0.0249**	0.0071**	0.0941**	0.0540*	0.0282**	0.0561**
Error	88	0.0009	0.0002	0.0043	0.0084	0.0034	0.003
GCA	8	0.0021**	0.0001	0.0054**	0.0104**	0.0061**	0.0201**
SCA	36	0.0009**	0.0005**	0.0153**	0.0087**	0.0026**	0.0106**
Error	88	0.0003	0.0001	0.0014	0.0028	0.0011	0.0011
GCA/SCA		2.4009	0.2852	0.3522	1.1970	2.3576	1.8949

Table (9) Mean performance of susceptibility index (SI) for yield and its component.

Genotypes	Days to heading	Plant height	Number of spike	Number of kernels	1000 kernal weight	Grain yield
yakora (p1)	1.01	0.99	0.97	0.85	1.16	0.74
Sakha 93 (p2)	0.99	0.93	0.99	0.50	1.14	0.67
Misr 2 (p3)	0.97	0.98	0.97	0.93	1.05	0.87
Sids 12 (p4)	0.97	0.94	1.01	0.99	1.01	0.88
Gemmeiza 11 (p5)	0.93	0.92	0.92	0.73	1.18	0.68
L 150 (p6)	0.96	0.98	0.95	0.87	1.02	0.80
L 116 (P7)	0.93	0.99	0.85	0.87	1.14	0.86
L 145 (P8)	0.94	0.95	0.97	0.78	1.11	0.80
L 124 (P9)	0.93	0.97	0.77	1.00	1.03	0.71
1x2	0.99	0.99	0.93	0.94	1.10	0.67
1x3	0.95	0.94	0.98	0.83	1.01	0.95
1x4	0.96	1.00	0.69	0.80	1.04	0.88
1x5	0.95	0.95	0.68	0.83	1.26	0.46
1x6	0.95	0.99	0.79	0.72	1.07	0.67
1x7	0.94	1.00	0.99	0.88	1.06	0.92
1x8	0.95	0.99	0.90	0.94	1.18	0.90
1x9	0.92	0.98	0.91	0.94	1.11	0.87
2x3	0.92	0.99	0.89	0.87	1.04	0.93
2x4	0.92	0.96	0.95	0.82	1.07	1.00
2x5	0.91	0.99	0.86	0.90	1.04	0.66
2x6	0.93	0.98	1.11	0.85	1.03	0.91
2x7	0.91	1.00	0.79	0.98	1.08	0.66
2x8	0.90	0.97	0.73	0.96	1.00	0.84
2x9	0.91	0.98	0.93	0.84	1.07	0.85
3x4	0.90	0.96	0.58	0.82	1.03	0.72
3x5	0.90	1.00	0.91	0.96	1.03	0.81
3x6	0.90	0.96	0.91	0.82	1.03	0.92
3x7	0.88	0.98	0.96	0.73	1.06	0.92
3x8	0.90	0.98	0.86	0.99	0.99	0.91
3x9	0.93	1.00	0.97	1.01	1.03	0.95
4x5	0.92	1.00	0.94	0.89	1.01	0.87
4x6	0.92	0.99	0.75	0.84	1.08	0.99
4x7	0.90	0.94	0.86	0.80	1.07	0.81
4x8	1.03	0.99	0.65	0.91	1.02	0.75
4x9	0.90	0.99	0.95	0.95	1.13	0.92
5x6	0.90	1.00	0.83	0.99	1.08	0.85
5x7	0.86	0.96	0.94	0.91	1.01	0.77
5x8	0.96	0.99	0.87	0.98	1.01	0.80
5x9	0.92	0.98	0.62	0.90	1.05	0.75
6x7	0.94	0.97	0.71	0.91	1.03	0.65
6x8	0.97	0.98	0.83	0.86	1.01	0.94
6x9	0.92	0.97	0.96	0.86	1.01	0.81
7x8	0.90	0.99	0.96	0.81	1.07	0.89
7x9	0.91	0.97	0.98	0.91	1.10	0.81
8x9	0.92	0.97	0.99	0.99	1.03	0.85
Mean of parents	0.96	0.96	0.93	0.84	1.09	0.78
Mean of crosses	0.92	0.98	0.87	0.89	1.06	0.83
Mean of Genotypes	0.93	0.98	0.88	0.88	1.06	0.82
LSD 5%	0.05	0.02	0.11	0.15	0.09	0.09

REFFERENCES

Abdel-Nour, Nadia A. R. (2006). Genetic studies on heading, maturity and yield and its component for late sowing conditions in wheat *(Triticum aestivum L.).* Egypt. J. Agric. 84(2): 445-462.

Amjad A. M., K. Jabran, S.I. Awan, A. Abbas, Ehsanullah, M. Zalkiffal and A. Tuba (2011). Morpho-physiological diversity and its implications for improving drought tolerance in grain sorghum at different growth stages. Aust J Crop Sci 5(3): 308-317

Andrew K.B., G.L. Hammer and R.G. Henzell (2000). Does maintaining green leaf area in sorghum improve yield under drought II. Dry matter production and yield. Crop Sci 40: 1037-1048

Arunachalam, V. (1976). Evaluation of diallel crosses by graphical and combining ability methods. Indian J. Genet. 36: 358-366.

Baker, R.J. (1978). Issues in diallel analysis. Crop Sci. 18: 533-536.

Chowdhry, M. A., G. Rabbani, G. M. Subhani and I. Khaliq (1999). Combining ability studies for some polygenic traits in *aestivum* Spp. Pak. J. Biol. Sci. 2(2): 434-437.

Dawwam, H. A., F. A. Hendawy and Mona M. Serage EL-Din (2007). Heterosis and combining ability analysis of some quantitative characters in bread wheat *(Triticum aestivum L.).* Minofiya .J. Agric. Res. 32(4): 1087-1108.

El-Hosary A.A., S.A. Omar and A.H.Wafaa (2009). Improving wheat production under drought conditions by using diallel crossing system. In: 6th International Plant Breeding Conference, Ismailia (Egypt).

Esmail, R.M. (2002). Estimation of genetic parameters in the F1 and F2 generation of diallel crosses of bread wheat *(Triticum aestivum L.).* Bull. NRC, Egypt. 27(1) 85-106.

Farooq, J., I. Khaliq, A.S. Khan and M.A. Pervez (2010). Studing the genetic mechanism of some yield contributing traits in wheat. (*Triticum aestivum*). Int. J. Agri. Biol. 12:241-246.

Fonsecca, S. and F. L. Patterson (1968). Hybrid vigour in seven-parent diallel cross in common wheat *(Triticum aestivum L.)*. Crop Sci. 2: 85-88.

Gomez, K.N. and A.A. Gomez (1984). Statistical Procedures for Agricultural Research. John.Wiley and Sons. Inc., New York, 2nd ed.

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

Hasnain Z., G. Abbas, A. Saeed, A. Shakeel, A. Muhammad and M.A. Rahim (2006). Combining ability for plant height and yield related traits in wheat *(Triticum aestivum L.).* J. Agric. Res. 44:167-175.

Joshi, S. K., S. N. Sharma, D. L. Singhania and R. S. Sain (2003). Genctic analysis of yield and its component traits in spring wheat. Acta Agronomica Hungrarica 51(2): 139-147.

Joshi, S.K., S. N. Sharma, D. L. Sinnghania and R. S. Sain (2004). Combining ability in the F1 and F2 generations of diallel cross in hexaploid wheat (Triticum aestivum L. Em. Thell). Hereditas.141:115-121.

Khan, N. U., H. Gul, M. S. Swati and M. A. Khan (1995). Estimation of heterotic response for yield and yield components in a 5 × 5 diallel cross of spring wheat. Sarhad J. Agric. 11(4):477-484.

Koumber, R.M. and M. A. EL-Beially (2005). Genetic analysis for yield and its attributes in bread wheat. J. Agric. Sci. Mansoura Univ. 30(4): 1827-1838.

Krishna, R. and Z. Ahmad (1992). Heterosis for yield components and developmental traits in spring wheat. Genetika 24(2): 127-132.

Larik, A.S., A. R. Mahar and H. M. I. Hafiz (1995). Heterosis and combining ability estimates in diallel cross of six cultivars of spring wheat. Wheat Information Serv. 80: 12-19.

Menshawy, A. M. M. **(2000).** Genetical studies on spring wheat. Ph.D. Thesis, Zagazig Univ. Egypt.

Motawea, M. H. (2006). Inheritance of earliness yield and yield components in wheat (*T. aestivum* L.em.Thell). Assuit J. of Agric. Sci. 32(2): 35-52.

Munir, l., M. S. Swati, F. Muhammad, R. Ahmad and M. lmtiaz (1999). Heterosis in different crosses of wheat *(Triticum aestivum L.).* Sarhad J. Agric. 15(4): 299- 303.

Prasad, K.D., M.F. Haque and D.K. Ganguli (1998). Heterosis studies for yield and its components in bread wheat *(Triticum aestivum L.)*. Indian J. Genet. 58: 97-100.

Rasul, I., A. S. Khan and Z. Ali (2002). Estimation of heterosis for yield and some yield components in bread wheat. Intern. J. Agric. Biol. 4(2): 214-216.

Sadeque, Z., A. Bhawmik and M. S. Ali (1991). Estimates of heterosis in wheat *(Triticum aestivum L.)* Ann. Bangladesh Agric. 1(2): 75-79 (Pl. Br. Absts., 64(2): 218, 1994).

Salem, R. A. Nagwa and S. M. Abdel Dayem (2006). Genetical study on some bread wheat crosses. J. Agric. Sci. Mansoura Univ. 31(8): 4873-4883.

Sangwan, V. P., B. D. Chaudhary, D. Singh and R. P. S. Kharb (1999). Genetic analysis of biomass production in wheat *(Triticum aestivum L.)* Ann. Biol. (Ludhiana) 15(1): 41-43 (Pl. Br. Absts., 69 (9): 8562, 1999).

Saulescu N.N., W.E. Kronstad and D.M. Moss (1995). Detection of genotypic differences in early growth response to water stress in wheat using the Snow and Tingey system. Crop Science ;35:928-931.

Steel, R. G. D. and J. H. Torrie (1980). Principles and Procedures of Statistics: A Biometrical Approach. McGraw Hill Book Co., Inc., New York, USA.

تحليل قوة الهجين والقدرة علي التآلف لقمح الخبز تحت ظروف الإجهاد والري الطبيعي

علي عبد المقصود الحصري ، سيدهم أسعد سيدهم ، محمد قاسم خليفه ، خالد عبد الواحد بيومي

قسم المحاصيل - كلية الزراعة - جامعة بنها - مصر.

تهدف هذه الدراسة إلي إمكانية التربية لتحمل الجفاف وكذلك دراسة قوة الهجين والقدرة علي التآلف ومعامل الحساسية للجفاف لصفات المحصول ومكوناته لتسعة آباء من القمح بالأضافة إلي ٣٦ هجين ناتجة منها بنظام Half diallel وذلك في محطة تجارب بحوث كلية زراعة مشتهر جامعة بنها، حيث تم عمل تجربتين بمزرعة الكلية كل تجربة عبارة عن ٩ أباء بالإضافة إلي ٣٦ هجين في قطاعات كاملة العشوائية (٣ مكررات) . في التجربة الأولي تم الري مرة واحدة بعد رية الزراعة بينما التجربة الثانية تم إجراء معاملات الري الطبيعية ، دونت البيانات علي خمسة نباتات فردية أخذت عشوائيا من كل قطعة تجريبية وقدرت قوة الهجين لكافة الصفات المدروسة كنسبة مئوية لإنحراف قيمة الهجين عن قيمة متوسط الأبوين أو قيمة الأب الأفضل. وتم تحليل البيانات باستخدام طريقة الهجن التبادلية (جرفنج ١٩٥٦) الطريقة الثانية الموديل الأول. أيضا تم تقدير معامل الحساسية للجفاف من البيانات الأساسية للتجربتين باستخدام معادلة (Saulescu et al 1995) . وكانت الصفات المدروسة هي : ميعاد طرد السنابل (يوم) - طول النبات (سم) - عدد سنابل النبات - عدد حبوب السنبلة – وزن ١٠٠٠ حبه – محصول النبات (جم) – معامل الحساسية للجفاف لهذه الصفات . كان التباين الراجع للتراكيب الوراثية الآباء والهجن والتفاعل بين الآباء والهجن معنويا لكل من ميعاد طرد السنابل ، طول النبات ، عدد السنابل / النبات ، عدد الحبوب / السنبلة ، وزن ١٠٠٠ حبة ومحصول النبات الفردي فيما عدا التباين الراجع لميعاد طرد السنابل بالنسبة للآباء تحت ظروف التحليل المشترك. أظهرت كلا من الآباءP8,P4,P4,P1,P7,P5 أعلي قيم لصفات ميعاد طرد السنابل ، طول النبات ، عدد السنابل / النبات ، وزن الـ١٠٠٠ حبة ، عدد الحبوب / السنبلة ومحصول النبات الفردي علي التوالي . كما أظهرت الهجن P4×P5, P4×P9, P5×P8, P1×P3, P3×P7, P1×P7 أعلي قيم لصفات ميعاد طرد السنابل ، طول النبات ، عدد السنابل / النبات ، وزن الـ١٠٠٠ حبة ، عدد الحبوب / السنبلة ومحصول النبات الفردي علي التوالي . كان التباين الراجع للقدرة العامة والخاصة علي التآالف معنويا للصفات تحت الدراسة . كانت النسبة بين القدرة العامة/القدرة الخاصة أعلي من الوحدة للصفات تحت الدراسة. وأظهرت السلالة P8 قدرة عامة علي التآلف لميعاد طرد السنابل ومحصول الحبوب. أظهرت كل من الهجين P6×P8 بالنسبلة لميعاد طرد السنابل ، الهجين P1×P4 بالنسبة لطول النبات ووزن الـ١٠٠٠ حبة ، الهجين P1×P5 بالنسبة لعدد السنابل/ النبات ، الهجين P1×P3 لصفة عدد الحبوب/السنبلة، الهجين P1×P7 بالنسبة لصفة محصول النبات الفردي قدرة خاصة علي التآلف معنوية. كان أحسن الأصناف بالنسبة لمعامل الحساسية للجفاف هو P4 لصفة محصول الحبوب . كان أفضل الهجن لمعامل الحساسية للجفاف هو الهجين P2×P4 بالنسبة لمحصول الحبوب.