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COMBINING ABILITY AND GENETIC COMPONENT ANALYSES FOR WHEAT UNDER WATER STRESS AND NORMAL IRRIGATION

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ABSTRACT: ***The aim of this study was to assess the variations among set a half diallel cross using eight varieties for drought characters, estimating combining ability and genetic components. For this objective, the investigation was carried out at the Experimental Farm of Etay El-baroud Agricultural Research Station during the two seasons of 2015/2016and 2016/2017, Eight diverse wheat varieties (Triticum aestivum, L.) and 28 F_1's were planted in two experiments. The first experiment was normally irrigated 4 irrigations (Non stress) and the second one was irrigated one time after planting irrigation (Stress). General (GCA) and specific (SCA) combining ability mean squares were highly significant for all studied traits in both environments as well as the combined analysis. Such results indicated that both types of combining ability are important in the inheritance of these traits.It could be concluded that the parent P7 (Giza 171) seemed to be the best general combiner for grain yield/ plant and most of yield components.***

N. kernel / spike in both exuberant and the combined only s , 1000 kernel weigh and harvest index in the drought treatment and the combined ability and grain yield in the normal irrigation.

The best ŝij effects were detected for the crosses P6 (Misr1)x P7 (Giza171), P7 x P8 (Giza168) and P1 (Gemmeiza) x P6 Misr 1 at both conditions and their combined for grain yield and some traits stadied.

Key words: ***Triticum aestivum, Drought, GCA, SCA, Stress, Water, Tolerance, wheat***

INTRODUCTION

Wheat (*Triticum aestivum,* L.) is the major cereal crop in Egypt as well as several other countries. World average cultivated area of wheat reached 221.73 million hectares in 2017; the total production was 751.36* million metric tons, with an average productivity of 3.39* metric tons per hectare. Egypt grew in 2017, 1.25* million hectares that produced 8.10* million metric tons of grains, with an average yield of 6.43* metric tons per hectare. With increasing population, it could hardly satisfy only 55% of local requirements. The increasing gap between production and consumption necessitates increasing wheat production in Egypt. To overcome this problem is to increasing the productivity of wheat through an efficient breading program.

Drought-resistant genotypes are able to maintain metabolic activities in their tissues with low water potential (Sairam *et al.,* 1990). Drought resistance in genotypes recently developed through breeding programs is mostly related to the plant's ability to protect itself from water loss under dry conditions, rather than plant tolerance against water loss. Protection from water loss is a result from different structural characteristics

(root length, seedling power, plant height, leaf area, flowering duration, etc.) related to plant development phenology and physiology (Blum, 2006). In environments where drought is experienced during the early growth periods, plant characteristics able to ensure germination–emergence and survival of seedlings should be taken into consideration (Monneveux and Ribaut, 2006).

Plant breeders focus on development of high yielding wheat cultivars by crossing good general combining lines and selecting desirable transgressive segregants from resulting hybrids for grain yield and other traits. Some researchers determined that the general combining ability effects for yield and other characters have played a significant role in selecting parents for grain yield (Akbar *et al.,* 2009).

The knowledge of combining ability is useful to assess differences among the genotypes and also, elucidate the nature and magnitude of gene actions involved. It has an important role to select parents and crosses and it helps to decide breeding methods to be followed to choose desirable individuals (Salgotra *et al.,* 2009).

The major objectives of the present investigation therefore to estimate gene action and the importance which should be given to these materials in a breeding program.

MATERIALS AND METHODS

The investigation was carried out at the Experimental Farm of Etay El-baroud Agricultural Research Station during the two seasons of 2015/2016and 2016/2017, Eight diverse wheat varieties (Triticum aestivum, L.) and 28 F_1's were planted in two experiments. Table (1).

In 2015/16 growing season, grains from each of the parental varieties were sown at a various sowing dates in order to overcome the differences in time of heading. During this season, all possible parental combinations without reciprocals were made among eight parents giving a total of twenty-eight crosses. In 2016/2017season, the eight parents and their twenty-eight possible F_1 crosses were sown on 17^{th} Nov. 2016. Two adjacent experiments were conducted. The first experiment was normally irrigated 4 irrigations (Non stress) and the second one was irrigated one time after planting irrigation (S tress). Each experiment was designed in a randomized complete block design with three replications. Each plot consisted of one ridge; three meters long with 20 cm between ridges and plants within ridge were 20 cm. apart allowing a total of 15 plants per plot. The dry method of planting was used in this concern. The other cultural practices of growing wheat were practiced. The studied raits.

1- **Number of spikes / plant**
2- **Number of the kernels for**
3- **1000-kernel weigh.**
4- **Grain yield per plant.**
5- **Biological yield**
6- **Harvest index.**

Statistical analysis:

The data of all experiments were subjected to proper statisical analysis of varince according to Snedecor and Cochran (1967). The combined analysis across the two experiments (stress and normal irrigation) were performed according to Cochran and Cox (1957).For comparason between means. General (GCA) and specific (SCA) combining ability estimates were obtained by employing Griffing (1956) diallel cross analysis designated as method 2 model 1.

Table (1): The name pedigree and source of the parental varieties.

NO	genotypes name	Pedigree	Source
1	Gemmeiza 7	CMH74 A. 630/5x//Seri 82/3/Agent (Gemiza 7)	Egypt
2	Gemmeiza 9	ALD"S"/HUAC//CMH74A-630/SX	Egypt
3	Gemmeiza 11	BOW"S"/KVS"S"//7C/SERI82/3/GIZA168/SAKHA61 GM-7892-2GM-1GM2GM-1GM-0GM	Egypt
4	Gemmeiza 12	OTUS /3/SARA/THB/VEE GMSS97YOO227S-5Y-010M-010Y-010M-2Y-1M-0Y-0GM	Egypt
5	Sids 12	BUC//7C/ALD/5/MAYA74/ON//1160-147/3/BB/GLL/4/CHAT"S"/6/MAYA/VUL//CMH74A.630/4*SX. SD7096-4SD-1SD-0SD	Egypt
6	Misr 1	OASIS / SKAUZ //4*BCN/3/2*PASTOR CMSS00Y01881T-050M-030Y-030M-030WGY-33M-0Y-0S	Egypt
7	Giza 171	Sakha 93 / Gemmeiza9 GZ003-101-1GZ-1GZ-2GZ-0GZ	Egypt
8	Giza 168	MRI/BUG/SEPICM933046-8M-OY-OM•2Y-O3-OGZ.	Egypt

RESULTS AND DISCUSSION

Analysis of variances: Mean squares of different wheat genotypes for all studied characters in each environment and their combined data are presented in Table (2). Statistical analysis revealed significant of irrigation treatments for all studied characters, indicating that the two irrigation regimes behaved differently for these characters.

In addition, mean squares due to genotypes were highly significant for all traits, providing evidence for presence of large amount of genetic variability, which considered adequate for further biometrical assessment. Significant differences for all traits were found among the parents at both conditions and their combined.

Meanwhile, significant differences of crosses mean squares were detected for all characters, reflecting the diversity of the parents for these studied characters, and that these diversities could be transmitted to the progenies. Also, mean squares of parents vs. crosses showed significant differences for all traits, indicating the presence of hybrid vigor of the studied barley genotypes .

For all traits, mean squares of genotypes x environments interactions were significant, indicating that genotypes responded differently to water regime for these traits and reflecting the possibility of selecting the most tolerant genotypes. Mean squares of parents x environments, crosses x environment and parent vs. crosses x environment were highly significant for alltraits, except parent vs. crosses x environment for 1000 kernel weight, revealing the performance of parents and most crosses were changed from environment to another.

Mean performances of the eight parents and their F_1 at stress and normal irrigation as well as their combined data are presented for all the studied characters in Table (3). It is clear that water stress condition decreased the mean number of spike per plant (NS/P), for the parents and hybrids. The highest NS/Pbelonged to parent 8 at the normal

Table (2): Mean squares for all traits studied.

S.O.V.	d.f.		Number of spikes per plant			Number of grains per spike			1000-Kernel weight		
	S.	Comb	NS	S	Comb.	N	S	Comb.	N	S	Comb.
Environment (E)		1			1247.23**			8129.12**			1246.61**
Rep/L	2	4	1.97	3.01	2.49*	28.31	4.30	16.30	25.04**	9.37	17.21**
Genotypes (G)	35	35	10.47**	20.91**	15.40**	206.95**	238.72**	261.71**	31.15**	30.99**	48.15**
parent (P)	7	7	9.94**	23.06**	22.79**	250.65**	426.41**	504.09**	100.83**	74.38**	160.22**
Cross C	27	27	10.01**	18.49**	13.85**	192.48**	198.88**	202.73**	13.01**	17.82**	16.79**
P.vs.C.	1	1	26.81**	71.14**	5.30*	291.92**	0.44	157.47**	33.13**	82.92**	110.44**
GxE		35			15.99**			183.96**			13.99**
p. xE		7			10.22**			172.97**			14.99**
C x E		27			14.65**			188.63**			14.04**
P.vs.c x E		1			92.65**			134.89**			5.61
Error		1	1.02	0.81	1247.23**	15.14	11.27	8129.12**	3.67	3.46	3.56
GCA	7	7	8.61**	6.27**	9.15**	87.82**	166.24**	225.34**	12.48**	9.37**	15.08**
SCA	28	28	6.56**	2.80**	4.13**	64.28**	57.90**	52.71**	9.86**	10.57**	16.29**
GCA x E		7			5.73**			28.72**			6.77**
SCA x E		28			5.23**			69.47**			4.14**
Error	70	140	0.34	0.27	0.31	5.05	3.76	4.40	1.22	1.15	1.19
GCA/SCA			1.31	2.24	2.22	1.37	2.87	4.27	1.27	0.89	0.93
GCA x E/GCA					0.63			0.13			0.45
SCA x E/SCA					1.27			1.32			0.25

*and **indicate significant at 0.05 and 0.01 levels of probability, respectively. NS= non stress , S= stress , Com= combined

Table (2): Cont.

S.O.V.	d.f.		Grain yield per plant			Biological yield per plant			Harvest index		
	S.	Comb.	NS	S	Comb.	NS	S	Comb.	NS	S	Comb.
Environment (E)		1			8366.40**			76233.29**			234.90**
Rep/L	2	4	27.79**	0.24	14.01**	25.38	3.64	14.51	32.43*	2.18	17.30
Genotypes (G)	35	35	90.01**	27.62**	60.20**	731.15**	227.75**	514.53**	122.56**	108.50**	94.01**
parent (P)	7	7	6.85	23.83**	14.23**	1084.40**	260.37**	787.96**	105.74**	334.34**	143.16**
Cross C	27	27	94.69**	29.12**	60.80**	637.64**	219.84**	429.12**	123.76**	52.11**	83.75**
P.vs.C.	1	1	545.64**	13.64*	365.92**	783.14**	213.01**	906.51**	207.94**	50.20	26.90
GxE		35			57.43**			444.38**			137.05**
p. xE		7			16.46**			556.80**			296.92**
C x E		27			63.02**			428.37**			92.11**
P.vs.c x E		1			193.36**			89.65*			231.24**
Error		1	3.53	3.40	3.47	23.11	18.08	20.60	10.20	15.46	12.83
GCA	7	7	36.03**	6.05**	21.13**	364.57**	33.54**	238.60**	25.52**	44.74**	22.34**
SCA	28	28	28.50**	10.00**	19.80**	213.50**	86.51**	154.74**	44.69**	34.02**	33.59**
GCA x E		7			20.95**			159.51**			47.93**
SCA x E		28			18.69**			145.28**			45.12**
Error	70	140	1.18	1.13	1.16	7.70	6.03	6.87	3.40	5.15	4.28
GCA/SCA			1.26	0.61	1.07	1.71	0.39	1.54	0.57	1.32	0.67
GCA x E/GCA					0.99			0.67			2.15
SCA x E/SCA					0.94			0.94			1.34

*and **indicate significant at 0.05 and 0.01 levels of probability, respectively. NS= non stress , S= stress , Com= combined

Table (3): The genotypes Mean performance for all traits studied.

	Number of spikes per plant			Number of grains per spike			1000-Kernel weight		
Genotypes	NS	S	Comb.	NS	S	Comb.	NS	S	Comb.
(P_1) Gemmeiza 7	12.00	9.97	10.98	73.32	50.31	61.82	44.79	41.91	43.35
(P_2) Gemmeiza 9	12.00	8.24	10.12	67.90	53.57	60.73	43.67	38.86	41.26
(P_3) Gemmeiza 11	6.90	6.50	6.70	85.35	48.65	67.00	43.23	36.60	39.91
(P_4) Gemmeiza 12	8.83	10.68	9.76	66.90	55.32	61.11	32.62	29.89	31.26
(P_5) Sids 12	7.70	5.70	6.70	85.60	79.25	82.43	48.63	36.61	42.62
(P_6) Misr 1	11.70	10.54	11.12	70.54	53.83	62.19	42.63	35.75	39.19
(P_7)Giza 171	13.17	8.03	10.60	75.95	73.88	74.92	43.40	40.84	42.12
(P_8) Gemmeiza 7	14.79	8.58	11.68	59.02	47.97	53.49	32.44	27.70	30.07
1x2	13.47	4.80	9.13	73.80	43.50	58.65	40.19	40.70	40.44
1x3	10.93	5.50	8.22	68.23	60.20	64.22	42.28	39.52	40.90
1x4	9.80	7.87	8.83	70.83	60.50	65.67	42.73	39.71	41.22
1x5	10.93	8.63	9.78	60.67	52.48	56.57	39.93	34.53	37.23
1x6	11.33	8.75	10.04	53.63	43.42	48.53	43.97	40.83	42.40
1x7	13.67	8.63	11.15	71.51	60.00	65.76	41.59	35.21	38.40
1x8	13.87	5.72	9.79	69.45	54.53	61.99	41.13	38.02	39.57
2x3	14.13	6.03	10.08	56.67	54.37	55.52	42.32	40.92	41.62
2x4	18.22	7.22	12.72	62.90	58.20	60.55	43.22	39.12	41.17
2x5	15.81	6.85	11.33	66.13	57.93	62.03	43.55	38.94	41.24
2x6	11.44	9.73	10.59	65.09	59.30	62.19	42.44	38.05	40.25
2x7	15.93	6.92	11.43	63.35	69.10	66.23	37.65	36.27	36.96
2x8	12.90	6.65	9.78	75.60	60.87	68.23	44.75	36.64	40.70
3x4	11.15	8.89	10.02	75.43	53.64	64.54	41.34	40.45	40.90
3x5	12.54	6.27	9.41	61.63	79.77	70.70	45.28	40.82	43.05
3x6	18.60	8.37	13.48	73.77	59.43	66.60	43.44	37.27	40.36
3x7	12.64	7.20	9.92	73.10	59.57	66.33	40.37	36.01	38.19
3x8	14.13	4.13	9.13	70.18	51.80	60.99	47.15	40.66	43.91
4x5	13.65	7.00	10.33	79.85	63.43	71.64	40.67	37.00	38.83
4x6	11.47	7.15	9.31	60.23	60.03	60.13	42.39	34.91	38.65
4x7	13.93	7.87	10.90	61.80	53.99	57.89	44.00	35.20	39.60
4x8	13.69	5.25	9.47	66.40	60.87	63.63	43.32	41.43	42.38
5x6	9.12	5.17	7.14	72.99	49.32	61.15	42.22	38.03	40.12
5x7	7.27	7.32	7.29	89.90	63.57	76.73	45.75	34.93	40.34
5x8	10.73	5.25	7.99	74.98	68.37	71.67	43.47	41.73	42.60
6x7	12.35	9.90	11.13	82.77	41.98	62.37	46.69	33.52	40.11
6x8	11.70	11.13	11.42	63.27	50.53	56.90	42.54	36.94	39.74
7x8	14.03	11.08	12.56	71.17	64.77	67.97	42.86	40.18	41.52
mean of parent	10.89	8.53	9.71	73.07	57.85	65.46	41.43	36.02	38.72
mean of cross	12.84	7.33	10.08	69.12	57.69	63.41	42.76	38.13	40.44
mean of Genotype	12.40	7.60	10.00	70.00	57.73	63.86	42.46	37.66	40.06
L.S.D 5%	1.64	1.47	1.53	6.32	5.45	5.82	3.11	3.02	3.02
L.S.D 1%	2.18	1.94	2.01	8.38	7.23	7.63	4.13	4.00	3.96

*and **indicate significant at 0.05 and 0.01 levels of probability, respectively. NS= non stress , S= stress , Com= combined

Table (3): Cont.

	Grain yield per plant			Biological yield per plant			Harvest index		
Genotypes	NS	S	Comb.	NS	S	Comb.	NS	S	Comb.
(P_1) Gemmeiza 7	22.13	12.65	17.39	72.70	40.63	56.67	30.65	31.14	30.89
(P_2) Gemmeiza 9	25.10	11.94	18.52	69.83	46.27	58.05	35.94	25.76	30.85
(P_3)Gemmeiza 11	23.40	16.58	19.99	102.32	30.84	66.58	22.85	53.80	38.32
(P_4) Gemmeiza 12	21.30	17.57	19.43	116.72	57.52	87.12	18.60	30.46	24.53
(P_5) Sids 12	20.47	12.01	16.24	66.23	38.43	52.33	30.89	32.47	31.68
(P_6) Misr 1	20.70	14.73	17.72	77.42	53.58	65.50	27.55	27.44	27.50
(P_7) Giza 171	22.07	9.38	15.72	79.54	55.47	67.51	27.73	17.06	22.40
(P_8) Gemmeiza 7	21.93	10.99	16.46	61.67	42.41	52.04	35.56	25.94	30.75
1x2	15.63	10.40	13.02	87.04	45.07	66.06	17.98	23.26	20.62
1x3	14.00	13.10	13.55	65.65	45.59	55.62	21.64	28.75	25.20
1x4	21.10	17.00	19.05	69.00	59.21	64.10	30.57	28.67	29.62
1x5	21.70	10.43	16.07	45.37	38.83	42.10	47.83	26.87	37.35
1x6	29.07	15.83	22.45	71.60	65.39	68.49	40.59	24.25	32.42
1x7	23.67	15.08	19.37	89.37	55.00	72.18	26.50	27.41	26.95
1x8	26.20	11.57	18.88	79.65	42.43	61.04	32.93	27.32	30.13
2x3	26.67	11.63	19.15	85.30	44.73	65.02	31.25	26.12	28.69
2x4	33.63	10.37	22.00	92.07	45.72	68.89	36.56	22.92	29.74
2x5	30.57	16.41	23.49	119.44	49.96	84.70	25.73	32.64	29.19
2x6	25.13	17.63	21.38	106.21	48.46	77.34	24.04	36.34	30.19
2x7	30.53	17.75	24.14	95.65	61.40	78.53	31.97	29.62	30.79
2x8	27.17	13.72	20.44	93.62	50.00	71.81	29.36	27.22	28.29
3x4	25.97	20.49	23.23	78.43	63.85	71.14	33.29	32.49	32.89
3x5	30.23	17.50	23.87	91.61	56.93	74.27	33.26	30.63	31.95
3x6	29.23	17.63	23.43	95.37	55.33	75.35	30.58	31.87	31.23
3x7	25.77	16.50	21.13	95.17	48.40	71.78	27.14	34.20	30.67
3x8	26.27	10.40	18.33	76.30	52.40	64.35	34.38	19.87	27.13
4x5	37.03	12.13	24.58	102.30	48.97	75.63	36.20	25.22	30.71
4x6	29.40	11.74	20.57	81.23	39.52	60.38	36.21	29.62	32.91
4x7	27.43	11.81	19.62	89.52	38.82	64.17	30.68	30.39	30.53
4x8	38.63	9.97	24.30	106.61	31.17	68.89	36.37	32.25	34.31
5x6	23.37	9.93	16.65	88.62	41.83	65.23	26.80	23.91	25.35
5x7	29.73	12.87	21.30	84.59	49.05	66.82	35.23	26.54	30.88
5x8	31.60	15.75	23.68	81.58	41.28	61.43	38.53	38.18	38.36
6x7	37.13	12.04	24.59	85.55	38.43	61.99	43.42	31.25	37.34
6x8	25.53	16.68	21.11	82.73	57.39	70.06	30.99	29.09	30.04
7x8	28.83	18.02	23.43	104.33	57.43	80.88	27.62	31.41	29.52
mean of parent	22.14	13.23	17.68	80.81	45.64	63.22	28.72	30.51	29.62
mean of cross	27.54	14.09	20.81	87.28	49.02	68.15	32.06	28.87	30.46
mean of Genotype	26.34	13.90	20.12	85.84	48.27	67.06	31.32	29.23	30.28
L.S.D 5%	3.05	2.99	2.98	7.81	6.91	7.26	5.19	6.39	5.73
L.S.D 1%	4.05	3.97	3.91	10.35	9.16	9.52	6.88	8.47	7.52

*and **indicate significant at 0.05 and 0.01 levels of probability, respectively. NS= non stress , S= stress , Com= combined

irrigation as well as the combined analysis. While, parent 5 showed the smallest NS/P at the normal irrigation as well as the combined analysis. Abd El-Aty and El-Borhamy (2007) found significant differences among wheat genotypes in NS/P. The highest NS/P was obtained from the following crosses; p_3x p_6 under normal environment and p_6x $p_8$at the drought condition.

With regard to number of kernels per spike (NK/S), the parents 5 showed the highest values at the two conditions and their combined while, parent 8 revealed lowest number of NK/S at the drought conditions. Also crosses; p_5 x p_7 showed the highest values at the normal condition and combined analysis and p_3 x p_5 gave the highest value at the drought condition. While, p_6 x p_7 showed the lowest values at the drought condition.

With regard to the parents for 1000-kernel weight, the heaviest were obtained from parent 5 under the normal condition and parent 1under drought condition as well as the combined analysis. The heaviest 1000-kernel weight of wheat hybrids were obtained from p_3 x $p_8$at normal irrigation and p_5 x p_8 under the drought condition. While, the lightest 1000- kernel weight of wheat crosses were relative to p_6 x p_7.

As a result of water stress condition, the average of grain yield/plant (GY/P) for parents and their hybrids was decreased. Several investigators reported that drought stress reduced photosynthesis and translocation rates and increased respiration, which reduced available assimilates for grain filling and finally decreased GY/P. Abd El-Aty and El-Borhamy (2007) found similar results. The highest GY/P were showed by parent 2 under the normal condition and parent 4under drought as well as the combined analysis. While, the lowest GY/P was obtained by parent 7 under drought data. The hybrids, p_4 x $p_{8,}$ at normal condition, p_3 x p_4 at drought condition and p_6 x p_7 at the combined analysisyielded more than the other crosses. While, p_5 x p_6 gave the lowest values under drought condition. The highest GY/P of these parents and crosses could be attributed to the highest GY/P of $p_3$and p_4, which may possessed the genes controlling in GY/P.

With regard to number of biological yield/plant, the parents 4 showed the highest values at the two conditions and their combined while, parent 3 revealed lowest number of biological yield/plant at the drought conditions. Also crosses; p_2 x p_5 showed the highest values at the normal condition and combined analysis. While, p_4 x p_8 showed the lowest values at the drought condition.

For harvest index, the parents 2 showed the highest values at the normal condition and parent 3 under drought condition and the combined analysis. while, parent 7 revealed lowest number of harvest index at the drought condition. Also crosses; p_5x p_8 showed the highest values at the drought condition and combined analysis. While, p_3 x p_8 showed the lowest values at the drought condition.

Mean performance of F1 crosses for all studied traits in each treatment as well as combined data are presented in Table (3). Regarding number of spikes plant-1, the highest mean values in normal irrigation (N/S) (18.6), were detected for the cross P3 x P6. And P6xP8 in(S) data (11.13).

For No. of grains/ spike, the cross P5 x P7 gave the highest values (89.9), (76.73), under (N/S) condition and combined analysis, and the cross P3 x P5 gave the highest values (79.77) in(S).

The parental combination P3 x P8 gave the highest mean values for 1000-

kernel weight in (N/S) treatment, and, gave higher value the cross P5 x P8(S).

For grain yield/ plant the cross P4 x P8 gave the highest values (38.63 g) under normal condition. However, the highest mean values for grain yield/ plant (20.49) were detected by P3 x P4. Moreover the cross P6 x P7 exhibited the heavier grain yield plant in the combined analysis being 24.59.

The highest mean values for biological yield / plant were detected by the cross P2 x P5 under normal condition and combined analysis (119.44g), (84.70).

For harvest index, the cross P5 x P8 gave the highest values (38.18), (38.36), under drought stress and combined analysis, and the cross P1 x P5 gave the highest values (47.83) in normal environment.

Combining ability analysis: Combining ability implies the capacity of parent to produce good progenies when crossed with the other parent.

Analysis of variance for combining ability as out lined by Griffing (1956) method 2 model 1 in each environment as well as their combined for all the studied traits in Table (2).

The results indicate that mean squares of general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the studied traits under the two environments and their combined.

The ratios between GCA and SCA exceeded the unity for all studied traits except for straw yield and harvest index at normal irrigation and grain yield/ plant, biological yield/ plant1000-kernel weight, straw yield, in the drought condition and straw yield at combined analysis, revealing that additive and additive x additive types of gene action are more important than non-additive gene action in controlling these traits. These results were coincident with those reported by Gomaa *et al* (2014) and El Hosary *et al.* (2015).

General combining ability effects: Estimates of GCA (ĝi) effects of all wheat parental genotypes for each trait in combined data are presented in Table (4). Such effects are being used to compare the average performance of each parent with the other and facilitate selection of parents for further improvement to drought tolerance.

Results indicated that the parent P1 gave significant and positive ĝi effects for1000-kernel weight in drought condition and the combined analysis. The parental P_2 exhibited significant and positive ĝi effects for no. of spikes per plant and biological yield per plant in normal irrigation environment and the combined analysis and1000-kernel weight under drought and combined analysis. The parent P_3 exhibited significant and positive ĝi effects for grain yield per plant under drought environment condition. Also, this parent considered the best combiner for biological yield per plant, No. of grains per spike at normal irrigation treatment and the combined analysis. The parent P_4 expressed significant and positive ĝi effects for grain yield per plant and biological yield per plant in normal environment and the combined analysis. The parent P_5expressed significant and positive ĝi effects for number of grains per spike in both and across environments, 1000-kernels wight, harvest index in normal and combined analysis. The parent p_6 expressed significant and positive ĝi effects for No. of spikes / plant, biological yield / plant under drought and combined analysis. The parent P_7 exhibited significant and negative ĝi effects for No. of spikes / plant, biological yield / plant and number of grains per spike both and across environments, grain yield / plant in normal and combined analysis. The

parent P_8 seemed to be the best general combiner for No. of spikes / plant and harvest index under normal environment as well as the combined analysis.

Table (4): Estimates of general combining ability effects for all studies treats.

	Number of spikes per plant			Number of grains per spike			1000-Kernel weight		
Parents	NS	S	Comb.	NS	S	Comb.	NS	S	Comb.
(P_1) Gemmeiza 7	-0.36*	0.15	-0.11	-1.52*	-4.43**	-2.98**	-0.08	1.34**	0.63**
(P_2) Gemmeiza 9	1.43**	-0.37*	0.53**	-3.06**	-0.92	-1.99**	-0.07	0.94**	0.44**
(P_3)Gemmeiza 11	-0.37*	-0.90**	-0.63**	1.97**	-0.35	0.81**	0.65	0.99**	0.82**
(P_4)Gemmeiza 12	-0.21	0.42**	0.11	-1.87**	0.17	-0.85**	-1.93**	-1.13**	-1.53**
(P_5) Sids 12	-1.62**	-1.05**	-1.33**	4.74**	7.38**	6.06**	1.60**	0.03	0.81**
(P_6) Misr 1	-0.22	1.29**	0.53**	-1.72*	-4.79**	-3.25**	0.68*	-0.79*	-0.05
(P_7) Giza 171	0.45*	0.66**	0.56**	3.55**	4.12**	3.83**	0.35	-0.59	-0.12
(P_8) Gemmeiza 7	0.90**	-0.20	0.35**	-2.09**	-1.19*	-1.64**	-1.21**	-0.79*	-1.00**
L.S.D(0.05) gi	0.34	0.31	0.13	1.32	1.14	0.48	0.65	0.63	0.25
L.S.D(0.01) gi	0.46	0.41	0.17	1.75	1.51	0.64	0.86	0.84	0.33
L.S.D(0.05) gi-gj	0.52	0.46	0.24	2.00	1.73	0.92	0.98	0.96	0.48
L.S.D(0.01) gi-gj	0.69	0.62	0.32	2.65	2.29	1.21	1.31	1.27	0.63

***and **indicate significant at 0.05 and 0.01 levels of probability, respectively. NS= non stress , S= stress , Com= combined**

Table (4): con.

	Grain yield per plant			Biological yield per plant			Harvest index		
Parents	NS	S	Comb.	NS	S	Comb.	NS	S	Comb.
(P_1) Gemmeiza 7	-4.15**	-0.63*	-2.39**	-11.95**	-0.17	-6.06**	-0.25	-1.43*	-0.84**
(P_2) Gemmeiza 9	0.24	-0.33	-0.04	4.64**	0.34	2.49**	-1.31*	-1.34*	-1.33**
(P_3)Gemmeiza 11	-1.22**	1.53**	0.16	1.99*	-0.55	0.72*	-2.46**	4.84**	1.19**
(P_4) Gemmeiza 12	1.87**	0.36	1.11**	8.00**	0.79	4.39**	-0.48	-0.06	-0.27
(P_5) Sids 12	0.81*	-0.60	0.10	-2.66**	-3.07**	-2.87**	2.35**	0.58	1.47**
(P_6) Misr 1	0.32	0.59	0.45**	-0.64	1.91*	0.63*	0.59	-0.19	0.20
(P_7) Giza 171	1.02**	-0.22	0.40**	3.07**	2.50**	2.79**	-0.38	-1.81**	-1.10**
(P_8) Gemmeiza 7	1.10**	-0.70*	0.20	-2.44**	-1.75*	-2.10**	1.95**	-0.59	0.68**
L.S.D(0.05) gi	0.64	0.63	0.25	1.63	1.45	0.61	1.09	1.34	0.48
L.S.D(0.01) gi	0.85	0.83	0.33	2.17	1.92	0.79	1.44	1.77	0.63
L.S.D(0.05) gi-gj	0.97	0.95	0.47	2.47	2.18	1.15	1.64	2.02	0.91
L.S.D(0.01) gi-gj	1.28	1.26	0.62	3.28	2.90	1.51	2.18	2.68	1.19

***and **indicate significant at 0.05 and 0.01 levels of probability, respectively. NS= non stress , S= stress , Com= combined**

Specific combining ability effects (Sij):

SCA (Sij) of the parental combinations computed for seven traits in combined analysis are presented in Table (5).

Table (5): Estimates of specific combining ability effects for all studied traits .

	Number of spikes per plant			Number of grains per spike			1000-Kernel weight		
crosses	NS	S	Comb.	NS	S	Comb.	NS	S	Comb.
P1xP2	0.00	-2.58**	-1.29**	8.39**	-8.88**	-0.25	-2.13*	0.75	-0.69
P1xP3	-0.74	-1.34**	-1.04**	-2.22	7.25**	2.52	-0.75	-0.47	-0.61
P1xP4	-2.04**	-0.30	-1.17**	4.23*	7.03**	5.63**	2.27*	1.84	2.05**
P1xP5	0.51	1.94**	1.22**	-12.55**	-8.20**	-10.37**	-4.05**	-4.49**	-4.27**
P1xP6	-0.49	-0.28	-0.38	-13.13**	-5.09**	-9.11**	0.90	2.62**	1.76*
P1xP7	1.17*	0.23	0.70*	-0.52	2.59	1.03	-1.15	-3.20**	-2.18**
P1xP8	0.93	-1.82**	-0.45	3.07	2.42	2.75*	-0.05	-0.19	-0.12
P2xP3	0.67	-0.30	0.19	-12.24**	-2.10	-7.17**	-0.72	1.33	0.30
P2xP4	4.59**	-0.43	2.08**	-2.16	1.21	-0.48	2.76**	1.65	2.20**
P2xP5	3.60**	0.67	2.13**	-5.54**	-6.26**	-5.90**	-0.44	0.31	-0.07
P2xP6	-2.17**	1.21*	-0.48	-0.13	7.28**	3.57**	-0.63	0.24	-0.20
P2xP7	1.65**	-0.97*	0.34	-7.13**	8.17**	0.52	-5.10**	-1.74	-3.42**
P2xP8	-1.83**	-0.38	-1.10**	10.76**	5.24**	8.00**	3.57**	-1.17	1.20
P3xP4	-0.68	1.77**	0.55	5.33*	-3.91*	0.71	0.15	2.93**	1.54*
P3xP5	2.13**	0.62	1.37**	-15.08**	15.00**	-0.04	0.57	2.14*	1.36
P3xP6	6.79**	0.38	3.58**	3.51	6.84**	5.17**	-0.35	-0.59	-0.47
P3xP7	0.15	-0.16	0.00	-2.42	-1.93	-2.18	-3.09**	-2.04*	-2.57**
P3xP8	1.20*	-2.36**	-0.58	0.30	-4.39*	-2.05	5.25**	2.80**	4.03**
P4xP5	3.07**	0.03	1.55**	6.99**	-1.85	2.57	-1.47	0.44	-0.51
P4xP6	-0.50	-2.16**	-1.33**	-6.18**	6.92**	0.37	1.18	-0.83	0.17
P4xP7	1.28*	-0.81	0.23	-9.88**	-8.03**	-8.95**	3.11**	-0.73	1.19
P4xP8	0.59	-2.57**	-0.99**	0.36	4.15*	2.26	3.99**	5.70**	4.84**
P5xP6	-1.45**	-2.67**	-2.06**	-0.03	-11.00**	-5.52**	-2.52*	1.13	-0.70
P5xP7	-3.97**	0.11	-1.93**	11.61**	-5.66**	2.98*	1.34	-2.16*	-0.41
P5xP8	-0.95	-1.09*	-1.02**	2.33	4.45*	3.39*	0.62	4.84**	2.73**
P6xP7	-0.28	0.35	0.03	10.93**	-15.08**	-2.07	3.20**	-2.76**	0.22
P6xP8	-1.38*	2.44**	0.53	-2.93	-1.22	-2.07	0.60	0.86	0.73
P7xP8	0.28	3.02**	1.65**	-0.29	4.11*	1.91	1.25	3.91**	2.58**
LSD5%(sij)	1.05	0.94	0.70	4.05	3.50	2.64	2.00	1.94	1.37
LSD1%(sij)	1.40	1.25	0.91	5.38	4.64	3.46	2.65	2.57	1.80
LSD5%(sij-sik)	1.56	1.39	1.03	6.00	5.18	3.90	2.95	2.87	2.03
LSD1%(sij-sik)	2.07	1.85	1.35	7.96	6.87	5.12	3.92	3.80	2.66
LSD5%(sij-ski)	1.47	1.31	0.34	5.66	4.88	1.30	2.79	2.70	0.68

LSD1%(sij-ski)	1.95	1.74	0.45	7.50	6.47	1.71	3.69	3.58	0.89

*and **indicate significant at 0.05 and 0.01 levels of probability, respectively. NS= non stress , S= stress , Com= combined

Table (5): con.

	Grain yield per plant			Biological yield per plant			Harvest index		
crosses	NS	S	Comb.	NS	S	Comb.	NS	S	Comb.
P1xP2	-6.81**	-2.54*	-4.67**	8.51**	-3.38	2.56	-11.78**	-3.20	-7.49**
P1xP3	-6.98**	-1.70	-4.34**	-10.23**	-1.97	-6.10**	-6.96**	-3.89	-5.43**
P1xP4	-2.97**	3.38**	0.21	-12.89**	10.32**	-1.29	-0.01	0.93	0.46
P1xP5	-1.31	-2.23*	-1.77*	-25.86**	-6.20**	-16.03**	14.42**	-1.51	6.45**
P1xP6	6.55**	1.98*	4.27**	-1.65	15.37**	6.86**	8.93**	-3.36	2.79*
P1xP7	0.45	2.04*	1.25	12.41**	4.39	8.40**	-4.19*	1.42	-1.38
P1xP8	2.90**	-1.00	0.95	8.20**	-3.92	2.14	-0.08	0.10	0.01
P2xP3	1.29	-3.47**	-1.09	-7.17**	-3.33	-5.25**	3.71*	-6.61**	-1.45
P2xP4	5.17**	-3.56**	0.81	-6.42*	-3.68	-5.05**	7.02**	-4.91*	1.06
P2xP5	3.17**	3.44**	3.31**	31.62**	4.42	18.02**	-6.63**	4.17*	-1.23
P2xP6	-1.77	3.47**	0.85	16.37**	-2.06	7.15**	-6.56**	8.64**	1.04
P2xP7	2.93**	4.41**	3.67**	2.10	10.28**	6.19**	2.35	3.54	2.94*
P2xP8	-0.52	0.85	0.16	5.58*	3.14	4.36**	-2.60	-0.08	-1.34
P3xP4	-1.03	4.70**	1.83**	-17.40**	15.35**	-1.03	4.91**	-1.52	1.69
P3xP5	4.30**	2.67**	3.48**	6.44*	12.28**	9.36**	2.05	-4.03	-0.99
P3xP6	3.79**	1.61	2.70**	8.18**	5.71*	6.94**	1.14	-2.01	-0.44
P3xP7	-0.38	1.29	0.46	4.27	-1.83	1.22	-1.33	1.94	0.31
P3xP8	0.04	-4.33**	-2.15**	-9.09**	6.43**	-1.33	3.58*	-13.62**	-5.02**
P4xP5	8.01**	-1.52	3.25**	11.12**	2.98	7.05**	3.01	-4.54*	-0.77
P4xP6	0.87	-3.10**	-1.12	-11.97**	-11.44**	-11.71**	4.78**	0.63	2.71*
P4xP7	-1.80	-2.22*	-2.01**	-7.39**	-12.74**	-10.07**	0.23	3.03	1.63
P4xP8	9.32**	-3.59**	2.86**	15.20**	-16.14**	-0.47	3.59*	3.67	3.63**
P5xP6	-4.10**	-3.95**	-4.03**	6.08*	-5.28*	0.40	-7.46**	-5.72**	-6.59**
P5xP7	1.57	-0.20	0.68	-1.66	1.35	-0.16	1.94	-1.46	0.24
P5xP8	3.35**	3.16**	3.25**	0.84	-2.17	-0.67	2.92	8.95**	5.93**
P6xP7	9.46**	-2.22*	3.62**	-2.71	-14.25**	-8.48**	11.90**	4.02	7.96**
P6xP8	-2.23*	2.89**	0.33	-0.02	8.96**	4.47**	-2.86	0.63	-1.11
P7xP8	0.37	5.05**	2.71**	17.86**	8.41**	13.14**	-5.26**	4.58*	-0.34
LSD5%(sij)	1.96	1.92	1.35	5.01	4.43	3.29	3.33	4.10	2.60
LSD1%(sij)	2.60	2.55	1.77	6.64	5.88	4.32	4.41	5.43	3.41
LSD5%(sij-sik)	2.90	2.84	2.00	7.41	6.55	4.87	4.92	6.06	3.85
LSD1%(sij-sik)	3.84	3.77	2.62	9.83	8.70	6.39	6.53	8.04	5.04

LSD5%(sij-ski)	2.73	2.68	0.67	6.99	6.18	1.62	4.64	5.71	1.28
LSD1%(sij-ski)	3.62	3.55	0.87	9.27	8.20	2.13	6.16	7.58	1.68

*and **indicate significant at 0.05 and 0.01 levels of probability, respectively. NS= non stress , S= stress , Com= combined

For number of spikes/ plant, nine, five and eight crosses expressed significant and positive ŝij effects in normal irrigation, drought stress and the combined analysis, respectively. However, the best ŝij effects were detected for the cross P_3 x P_6 (6.79) in normal irrigation treatment, and combined analysis (3.58). For number of grains per spike, seven crosses in normal irrigation treatment, eleven crosses in drought stress condition and seven in the combined analysis expressed significant and positive ŝij effects. Moreover, the cross P_5 x P_7 gave the most desirable ŝij effects for this trait in normal irrigation (11.61), the cross P3 x P5 in drought stress (15.00) and the cross P2 x P8 combined data (8.00). Regarding 1000-kernel weight, seven, seven and eight cross combinations expressed significant and positive ŝij effects in normal irrigation, drought stress and the combined data, respectively. The cross P_3 x P_8 gave the most desirable ŝij effects for 1000-kernel weight in normal irrigation, the cross P4xP8 in drought treatment, and the combined analysis being 5.25, 5.70 and 4.84, respectively. Eleven, eleven and eleven cross combinations exhibited significant and positive ŝij effects for grain yield / plant in non-stress, stress water environments, and the combined analysis, respectively. However, the best ŝij effects were detected for the crosses P_6 x P_7, P_7 x P_8 and P_1 x P_6 for the respective environments, respectively. Twelve, nine and eleven cross combinations exhibited significant and positive ŝij effects for biological yield/ plant in non-stress, stress environments, and the combined analysis. For harvest index, nine crosses in normal irrigation treatment, four cross in drought stress condition and seven in the combined analysis expressed significant and positive ŝij effects. Moreover, the cross P_1 x P_5 gave the most desirable ŝij effects for this trait in normal irrigation (14.42), the cross P5 x P8 in drought stress (8.95) and the cross P6 x P7 combined data (7.96).

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القدرة على التألف وتحليل مكونات التباين فى القمح تحت الإجهاد المائى والرى الطبيعى

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الملخص العربى

أجرى هذا البحث بهدف تقدير مكونات التباين والقدره على الائتلاف تحت ظروف الاجهاد المائى والرى الطبيعى والتربه لتحمل ظروف الجفاف فى القمح. وقد إستخدم لهذا الغرض ثمانية أباء عبارة عن (جميزة ٧ , جميزة ٩ , جميزة ١١ , جميزة ١٢ , سدس ١٢ , مصر ١ , جيزة ١٧١ , جيزه ١٦٨)

وتم عمل الهجن التبادليه النصف دائريه بين الأباء خلال موسم ٢٠١٥/٢٠١٦م فى مزرعة محطة بحوث زرزوره بايتاى البارود. وفى موسم ٢٠١٦/٢٠١٧م تم زراعة الاباء والهجن الناتجه منها (٢٨ هجين) فى تجربتين , التجربة الاولى رويت رية واحدة بعد رية الزراعة. والتجربة الثانية رويت بأربع ريات بعد رية الزراعة.

وكلا التجربتين مصممتان فى تصميم قطاعات كاملة النسبة ذو ثلاث مكررات وتم اخذ القياسات التاليه:

١- عدد السنابل /نبات
٢- عدد الحبوب/ السنبلة
٣- وزن الالف حبة
٤- وزن الحبوب/نبات
٥- المحصول البيولوجى/نبات
٦- دليل الحصاد

وكانت اهم النتائج المتحصل عليها كالاتى:

١- كان التباين الراجع بين ظروف الرى المختلفة معنوى جدا لكل الصفات المدروسه مما يدل على وجود إختلافات بين ظروف الإجهاد والرى الطبيعى.
٢- كما كان التباين الراجع للأباء والهجن والتفاعل معنوى فى معظم الصفات المدروسه وايضا كان التباين الراجع للقدرة العامة والخاصة على التالف معنويا لكل الصفات المدروسة فى كلا التجربتين والتحليل المشترك.
٣- اعطى الاب (سدس١٢) أفضل الاباء فى صفات عدد الحبوب فى السنبلة ووزن الالف حبة فى كلا التجربتين والتحليل المشترك وكذلك دليل الحصاد تحت ظروف الاجهاد والتحليل المشترك.
٤- اعطى الاب (جيزة ١٦٨) افضل الاباء فى صفات عدد السنابل للنبات وعدد الحبوب فى السنبله فى كلا التجربتين والتحليل المشترك
٥- سجل الهجين (جميزة١٢ x جيزة ١٦٨) افضل الهجن فى صفة المحصول تحت ظروف الرى الطبيعى والهجين (جميزة ١١ x جميزة ١٢) تحت ظروف الاجهاد بينما تفوق الهجين (مصر ١ x جيزة ١٧١) والتحليل المشترك.
٦- كما سجلت أربعة تراكيب وراثية وهى :
(P1*P6 , P2*P5 , P3*P5 , P8*P5) كأحسن الهجن فى صفة المحصول تحت ظروف ألاجهاد والرى والتحليل المشترك.

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