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UTILIZATION OF DIALLEL CROSSES TO DETERMINE COMBINING ABILITY AND HETEROSIS IN WHEAT GROWN UNDER DROUGHT AND NORMAL IRRIGATION TREATMENTS

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ABSTRACT

The studied parents were crossed in 8x8 half diallel scheme in 2015/2016. Parents and their 28 F_1 crosses were evaluated under normal and stress conditions during 2016/2017 in two irrigation levels experiments. The mean squares were significant for all studied traits. The highest mean values were detected by parents P_3, P_2, P_1, P_5 and P_8 for plant height, no of spikelets/ spike, no of spike/ plant, 1000-kernel weight, biological yield/ plant and grain yield/ plant in the combined analysis, respectively. While, the highest mean values were recorded under combined analysis with crosses P_2xP_5 for biological yield/ plant and the cross P6xP8 for grain yield / plant. Mean squares for combining ability estimates were highly significant for all studied traits. Less GCA /SCA ratios relative to unity were found for most traits studied traits, revealing that non-additive gene action is more important than additive and additive x additive types of gene action in controlling these traits. However, high ratio GCA /SCA exceeded the unity for grain weight/ plant, revealing that additive and additive x additive types of gene action are more important than non-additive gene action in controlling this trait. The parental P_1 exhibited positive and significant ĝi effects for plant height, No of spike/ plant, 1000-kernel weight, and biological yield/ plant. The parental P_4 exhibited positive and significant $\hat{g}_i$ effects for 1000-kernel weight, and grain weight/ plant. The parental P_8 exhibited positive and significant ĝi effects for biological yield/ plant and grain weight/ plant. The highest desirable SCA effects were obtained with the crosses P_1xP_6, P_1xP_7, P_2xP_7, P_3xP_4, P_3xP_8, P_4xP_5, P_4xP_6, P_5xP_7 and P_6xP_8 for grain yield/ plant which exhibited significant and positive $\hat{s}_{ij}$ effects.

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

INTRODUCTION

Wheat (*Triticum aestivum* L.) is the major cereal crop in Egypt and several other countries. World average cultivated area of wheat was 221.73* million hectares in 2017; the total production was 751.36 million metric tons, with an average productivity of 3.39 metric tons hectare^{-1}. In Egypt wheat grew in 1.25 million hectares that produced 8.10 million metric tons of grains, with an average yield of 6.43 metric tons hectare^{-1} (USDA, 2018). 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.

Stresses can occur at any stage of plant growth and development, thus illustrating the dynamic nature of crop plants and their productivity is needed. Drought among abiotic stresses is the most widespread and limiting crop productivity. There are definitions of drought, which include precipitation, evapo-transpiration, potential evapotranspiration, temperature, humidity and other factors individually or in combination (Renu and Suresh, 1998). Also selection for genotypes with increased productivity in drought environments has been an important goal of many plant breeding programs, the biological basis for drought tolerance is still poorly understood.

The diallel cross designs are frequently used in plant breeding research to obtain information about genetic properties of parental lines or estimates of general combining ability (GCA), specific combining ability (SCA) and heritability (Iqbal *et al*., 2007 and EL Saadoown *et al*. 2017). In addition, the diallel cross technique was reported to provide early information on the genetic behavior of these attributes in the first generation (Chowdhry *et al*., 1992 and Topal *et al*., 2004). Diallel analysis technique is the choice of providing such detailed genetic information for selecting breeding materials that show great promise for success (Lonnquit and Gardner, 1961 and EL Saadoown *et al.* 2018).

Therefore, the investigation aimed to assess the variations amongst a half diallel crosses among eight genotypes for drought avoidance and drought tolerance traits.

MATERIALS AND METHODS

Plant materials: Eight wheat genotypes, representing a wide range of diversity for several traits (Table 1).

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

NO	Entry name	Pedigree	Source
1	Yakora Rojo	Ciano 67/Sonora 6411 Klien Rendidor/3/1L815626Y-2M-1Y-0M-302M	CIMMYT
2	Sakha 93	S 92/TR 810328 S8871-1S-2S-1S-0S	Egypt
3	Masr 1	OASIS/SKAUZ//4*BCN/3/2*PASTOR	Egypt
4	Drought 4	Landraces	Egypt
5	Shandawel 1	SITE//MO/4/NAC/TH.AC//3*PVN/3/MIRLO/BUC	Egypt
6	Gemiza 9	ALD”S”/HUAC”S”//CMH74A.630/5X	Egypt
7	Giza 171	SAKHA 93 / GEMMEIZA 9 S.6-1GZ-4GZ-1GZ-2GZ-0S	Egypt
8	Sides 13	KAUZ"S"//TSI/SNB"S"	Egypt

Line No 4 was developed in the Department of Agronomy , Faculty of Agric. at Moshtohor , Banha Univ. by Prof. Dr. M. El.Badawy.

Field experiments: This investigation was carried out at the Experiment, Research Station of Moshtohor Faculty of Agriculture, Benha University, Kalubia Governorate, Egypt. In 2015/2016 growing season, the parents were crossed in a 8x8 diallel cross excluding reciprocals giving a total of twenty-eight crosses. In 2016/2017 two experiments using randomized complete block design with three replications were carried out. Each experiment contained the eight parents and their resulting 28 F_1's. The sowing date was on 4^{th} Dec. 2016. The first experiment was irrigated only once after planting irrigation and the second one was normally irrigated 5 irrigations. Plots of parents and F_1's consisted of one row, 3 m-long, with spacing of 30 cm between rows and 20 cm between plants. The dry method of planting was used in this study. The other cultural practices of growing wheat were practiced. The amounts of total rainfall during the evaluating season were recorded in Table (2).

Table (2:) Monthly averages of temperature, relative humidity (R.H.) and total rain fall during 2016/2017 season at Kalubia (Moshtohor).

Months	Temperature C		R.H. (%)	Rain fall mm/month
	Max.	Min.		
Dec.2016	19.7	9.2	51.3	0.5
Jan.2017	17.7	6.1	55.9	1.6
Feb.2017	20.4	7.8	47.2	0.8
Mar.2017	25.8	11.4	37.3	0.4
Apr.2017	29.1	14.4	38.9	0.3
May.2017	34.5	19.0	32.1	----

According to meteorological weather station Moshtohor.

Ten guarded plants from parents and the F_1's were selected randomly from each plot for recording observations on different characters. The characters studied were, Plant height (cm), No. of spikelets /spike, No. of spikes /plant, 1000- kernel weight (g), biological yield/ plant and grain yield/ plant (g).

Data analysis: Analysis of variance was conducted as outlined by Steel and Torrie (1980) for all 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).

RESULTS AND DISCUSSION

Analyses of variance for yield and its components under drought and normal irrigation and combined analysis across the mention environments are presented in Table 3. Results indicated that mean squares due to irrigation treatments (Environments) were highly significant for all studied traits indicating overall differences between the two environments of study.

Genotypes mean squares were significant for all studied traits indicating wide diversity between all genotypes used in this work. Moreover, significant mean squares between genotypes and environment interaction were detected for all studied traits. This result indicated that genotypes responded differently to different environments for the mention traits.

Mean squares due to parents were highly significant for all traits in both and across studied environments except for Number of spike / plant in drought treatment, indicating that these parents are differently in the aforementioned significant traits. Moreover, mean squares due to the interaction between parents and environments were significant for all studied traits. Such result indicated that wheat parents responded differently to stress and non-stress conditions for these traits.

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

S.O.V.	Df	plant height	Number of spikelets/ spike	Number of spike / plant	1000-kernel weight	Biological yield/ plant	grain weight / plant
Drought environment							
Rep	**2**	11.03	2.85*	3.95	2.22	64.33*	27.88**
Genotypes (G)	**35**	188.09**	4.83**	10.78**	116.39**	3213.69**	138.93**
Parent (P)	**7**	127.71**	11.45**	14.33**	73.41**	1992.57**	143.71**
Cross (C)	**27**	209.44**	3.27**	9.88**	128.41**	3639.48**	142.27**
P vs C.	**1**	34.38*	0.69	10.33*	92.71**	265.01**	15.46*
Error	**70**	5.73	0.7	2.51	2.84	13.29	5.59
Normal environment							
Rep	**2**	5.06	0.17	5.90	2.99	30.70	20.85*
Genotypes (G)	**35**	134.78**	3.21**	5.30**	103.79**	1751.33**	120.38**
Parent (P)	**7**	101.57**	3.013**	2.83	82.83**	1454.07**	146.03**
Cross (C)	**27**	140.46**	3.28**	5.90**	98.16**	1843.45**	116.82**
P vs C.	**1**	214.13**	2.64	6.35	402.90**	672.45**	36.91*
Error	**70**	8.46	0.75	2.32	3.00	12.54	6.48
Combined analysis							
Irrigation (I)	**1**	5724.74**	148.52**	436.34**	4228.53**	136604.74**	12580.96**
Rep/ I	**4**	8.05	1.5	4.93	2.61	47.519**	24.37**
Genotypes (G)	**35**	177.09**	6.38**	6.46**	139.08**	3555.66**	132.89**
Parent (P)	**7**	25.14**	11.12**	10.69**	50.02**	1914.43**	100.78**
Cross (C)	**27**	215.26**	5.37**	5.59**	165.31**	4060.93**	144.28**
P vs C.	**1**	210.06**	0.32	0.24	54.54**	1401.94**	50.07**
G x I	**35**	145.79**	1.67**	9.62**	81.10**	1409.36**	126.42**
p x I	**7**	204.14**	3.34**	6.47*	106.22**	1532.21**	188.96**
C x I	**27**	134.64**	1.18**	10.19**	61.26**	1422.01**	114.80**
P.vs.C x I	**1**	38.45*	3.01*	16.44*	441.07**	207.95**	2.30
Error	**140**	7.09	0.72	2.41	2.92	12.91	6.04

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

Mean performance

Results in Table (4) showed the average of plant height, yield and its components traits at the combined across environments. It's clear that the parental line P_8 gave the lowest mean value for plant height and did not differ significantly than P1, P2, P4, P5 and P6. On the other hand, P3 and P_6 was the tallest parent. Plant height for crosses ranged from 67.00 cm (P_2xP_8) to 96.97cm (P_2xP_4). Moreover, the crosses P_1xP_2, P_2xP_7, and P_3xP_4 did not differ significantly than the tallest hybrid P_2xP_4. 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. The highest parents mean value for No of spikelets/ spike (22.43 cm) was detected for P_2. However, eleven crosses P_1xP_2, P_1xP_3, P_1xP_5, P_2xP_4, P_2xP_5, P_2xP_8, P_3xP_5, P_3xP_8, P_4xP_5, P_4xP_6 and P_5xP_6 exhibited highest values for No of spikelets/ spike. For No. of spike/ plant the parent P_1 and the cross P_4xP_6 give the highest number of spikes/ plant. However, there were insignificant differences between the cross P_4xP_6 and twenty crosses for this traits. Heavier 1000-kernel weight was detected for P_8, P_1xP_2, P_1xP_4, P_2xP_7, P_2xP_8, and P_4xP_6. The parental No 5 (P_5) gave the highest mean value for biological yield/ plant and ranked the first parents for this trait. Moreover, the cross P_2xP_5, P_2xP_7 and P_5xP_6 exhibited the highest crosses for biological yield/ plant.

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

Genotypes	Plant height	Number of spikelets/ spike	Number of spike / plant	1000-kernel weight	Biological yield/ plant	Grain weight / plant	Heterosis For grain weight / plant relative to	
P_1	87.67	21.77	24.17	43.63	166.83	35.52		
P_2	88.33	22.43	20.33	46.55	143.67	33.12		
P_3	93.50	20.87	21.67	43.47	142.83	40.92		
P_4	88.33	18.17	22.00	43.40	184.00	42.87		
P_5	88.33	21.93	20.83	39.50	190.17	38.67		
P_6	89.50	21.83	23.17	42.53	151.67	36.93		
P_7	87.33	21.87	22.83	40.00	166.17	43.28		
P_8	87.17	20.53	23.50	47.97	175.50	44.60	M.P	B.P
1x2	96.33	21.50	21.33	48.32	168.33	28.75	-16.22**	-19.05**
1x3	80.67	21.73	23.33	45.07	208.83	38.67	1.18	-5.50
1x4	86.17	20.80	22.83	49.40	148.00	33.33	-14.95**	-22.24**
1x5	90.67	22.07	23.83	37.12	168.33	36.48	-1.64	-5.65
1x6	85.33	20.83	22.67	41.45	181.17	39.24	8.31	6.23
1x7	89.33	19.90	22.67	44.13	183.17	44.38	12.65*	2.54
1x8	84.00	19.77	22.00	34.37	195.33	39.82	-0.60	-10.72*
2x3	91.67	20.33	23.17	39.00	167.50	36.20	-2.20	-11.53*
2x4	96.67	21.97	22.50	37.42	160.67	32.47	-14.54**	-24.26**
2x5	83.00	22.10	23.67	40.73	212.50	34.28	-4.48	-11.34*
2x6	82.17	18.90	23.67	32.83	149.33	35.98	2.74	-2.57
2x7	92.50	21.03	21.17	50.58	212.17	40.80	6.81	-5.74
2x8	67.00	21.47	21.67	49.17	159.67	40.07	3.11	-10.16*
3x4	93.67	21.17	21.83	40.35	193.33	43.62	4.12	1.75
3x5	87.67	21.65	23.00	39.62	170.50	31.00	-22.09**	-24.24**
3x6	79.00	22.07	20.67	48.33	145.17	28.48	-26.83**	-30.39**
3x7	81.50	22.33	22.00	44.82	185.33	41.03	-2.53	-5.20
3x8	84.67	20.80	20.67	38.67	177.00	46.18	8.01	3.55
4x5	85.50	22.13	21.50	42.72	170.33	41.98	2.98	-2.06
4x6	83.67	21.60	24.33	46.77	162.50	41.37	3.68	-3.50
4x7	82.50	20.33	22.67	37.95	111.50	37.30	-13.41**	-13.82**
4x8	83.50	21.63	22.00	48.70	148.33	36.22	-17.19**	-18.80**
5x6	88.17	22.60	22.33	44.25	209.17	36.78	-2.69	-4.87
5x7	91.00	19.70	23.17	42.27	115.17	44.72	9.13	3.31
5x8	86.33	19.97	22.83	40.85	193.50	41.53	-0.24	-6.88
6x7	89.00	19.93	22.67	47.63	154.33	34.22	-14.69**	-20.95**
6x8	85.83	20.80	21.83	34.10	157.00	45.80	12.35*	2.69
7x8	91.67	21.20	21.00	34.23	186.33	42.52	-3.24	-4.67
mean of parent	88.77	21.18	22.31	43.38	165.10	39.49		
mean of cross	86.40	21.08	22.39	42.17	171.23	38.33		
mean of Genotype	86.93	21.10	22.38	42.44	169.87	38.59		
L.S.D 5%	4.26	1.36	2.49	2.73	5.75	3.93		
L.S.D 1%	5.59	1.78	3.26	3.59	7.54	5.16		

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

Parent No 8 (P_8) and the crosses P_1xP_7, P_3xP_4, P_3xP_8, P_4xP_5, P_5xP_7, P_6xP_8 and P_7xP_8 gave the highest mean values for grain yield / plant. Therefore, these crosses could be efficient for prospective wheat breeding programs aiming at improving wheat grain yield. The hybrids P_1xP_7 and P_6xP_8 and gave maximum positive heterosis over mid parent reached12.65* and 12.35* for the mention crosses, respectively. Eight parents out of studied crosses exhibited significant and negative superiority relative to mid parent. However, sixteen crosses did not differ significantly relative to better parent. Maximum yield recorded by these hybrids has been attributed to increase in average weight of grain yield/ plant.

Combining ability

The analysis of variance for combining ability for plant height, No of spikelets/ spike, number of spikes/ plant, 1000-kernel weight, biological yield, and grain yield/ plant, under drought treatment, normal irrigation and combined analysis is presented in Table 5.

General (GCA) and specific (SCA) combining ability mean squares were highly significant for all studied traits in both environments as well as combined analysis except for Number of spike / plant under drought and normal conditions. Such results indicated that both types of combining ability are important in the inheritance of these traits.

Moreover, the ratios between GCA and SCA were less the unity for all studied traits, except, grain weight/ plant, at both and across environments, plant height at drought treatment, 1000-kernel weight and Biological yield/ plant at normal irrigation environment. Such results revealed that non-additive types of gene action are more important than additive and additive x additive gene action in controlling these traits. For the exclusion cases, the additive and additive x additive types of gene action are more important than non-additive gene action in controlling these traits. The genetic variance was previously reported to be mostly due to additive effects for plant height by Menshawy (2004) and El Hosary *et al*. (2009); for spikes/ plant by El Seidy and Hamada (1997), El Borhamy (2000), Gomaa*et al* (2014); for 1000-grain weight by El Seidy and Hamada (1997), El Borhamy (2000), and for grain yield/ plant by El Seidy and Hamada (1997), El Seidy and Hamada (2000), El Borhamy (2000), Abd El-Aty and Katta (2002), El Hosary *et al*. (2012), Gomaa et al (2014) and EL Saadoown *et al.* (2018).

The mean squares of the interaction between GCA, SCA and irrigation treatments were significant for all studied traits except GCA x E for number of spikelets/ spike and number of spike/ plant. Such result indicated that the additive and non-additive types of gene action differed significantly from one environment to another for these traits. Similar results were reported by El-Seidy and Hamada (1997), El-Seidy and Hamada (2000).

The ratio GCA x irrigation/ GCA was much higher that of SCA x irrigation/ SCA for plant height, 1000-kernel weight and biological yield/ plant. indicating that additive effects were much more influenced by environments than non-additive genetic one. On the other hand, GCA x environment/ GCA was much smaller that of SCA x irrigation/ SCA treatments for grain yield/ plant indicating the non-additive gene effects more changed than additive effect. Such results are in harmony with those obtained by El Hosary and Nour El Deen (2015).

Table (5): Combining abilities 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	plant height	Number of spikelets/ spike	Number of spike / plant	1000-kernel weight	Biological yield/ plant	grain weight / plant
Drought environment							
GCA	7	65.17**	1.35**	2.54*	11.49**	1007.41**	75.59**
SCA	28	62.08**	1.68**	3.86**	45.62**	1087.18**	38.99**
Error	70	1.91	0.23	0.84	0.95	4.43	1.86
GCA/SCA		1.05	0.81	0.66	0.25	0.93	1.94
Normal environment							
GCA	7	34.65**	0.56*	0.84	38.86**	701.48**	51.66**
SCA	28	47.50**	1.20**	2.00**	33.53**	554.35**	37.24**
Error	70	2.82	0.25	0.77	1.00	4.18	2.16
GCA/SCA		0.73	0.47	0.42	1.16	1.27	1.39
Combined analysis							
GCA	7	27.47**	1.58**	2.05*	12.95**	701.08**	91.79**
SCA	28	66.92**	2.26**	2.18**	54.71**	1306.25**	32.42**
GCA x L	7	72.35**	0.33	1.33	37.41**	1007.80**	35.45**
SCA x L	28	42.66**	0.61**	3.68**	24.44**	335.28**	43.81**
Error	140	2.36	0.24	0.80	0.97	4.30	2.01
GCA/SCA		0.41	0.7	0.94	0.24	0.54	2.83
GCA x L/GCA		2.63	-	-	2.89	1.44	0.39
SCA x L/SCA		0.64	-	-	0.45	0.26	1.35

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

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 (5).

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. Results indicate that the parental P_1 gave positive significant ĝi effects for plant height, no of spike/ plant, 1000-kernel weight and biological yield/ plant. P_2 exhibited significant and positive ĝi effects for plant height, No. of spikeletets/ spike and 1000-kernel weight. P_3 gave useful significant ĝi effects for No of spikeletes/ spike and showed either in significant or negative and significant ĝi effects for the respect traits.

P_4 expressed significant and positive ĝi effects for 1000-kernel weight and grain weight/ plant. P_5 seemed good general combiner for plant height, No of spikelets/ spike and biological yield/ plant.

P_6 exhibited negative significant ĝi effects for plant height and gave positive significant ĝi effects for Number of spike / plant. P_7 showed positive significant ĝi effects for plant height, and grain weight / plant. Also, it ranked the second combiner for grain weight/ plant. P_8 gave negative and significant combiner for plant height. On the same context, this parent exhibited the highest positive and significant ĝi effects and ranked the first for biological yield/ plant and grain weight/ plant. It is seemed that the best combiner for grain yield/ plant and most of its components.

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

Parent	plant height	Number of spikelets/ spike	Number of spike / plant	1000-kernel weight	Biological yield/ plant	grain weight / plant
P_1	0.55**	0.02	0.56**	0.51**	5.80**	-1.56**
P_2	0.37*	0.22**	-0.35**	0.92**	-1.13**	-3.25**
P_3	0.35	0.19**	-0.34**	0.08	0.45	-0.03
P_4	0.60**	-0.40**	0.03	0.81**	-6.62**	0.47**
P_5	0.67**	0.42**	0.06	-1.54**	9.10**	-0.32
P_6	-1.02**	0.05	0.31**	-0.15	-6.68**	-1.15**
P_7	0.98**	-0.18**	-0.04	-0.04	-4.85**	2.43**
P_8	-2.50**	-0.32**	-0.24*	-0.60**	3.93**	3.41**
L.S.D(0.05) gi	0.36	0.11	0.21	0.23	0.48	0.33
L.S.D(0.01) gi	0.47	0.15	0.27	0.30	0.63	0.43
L.S.D(0.05) gi-gj	0.67	0.21	0.39	0.43	0.91	0.62
L.S.D(0.01) gi-gj	0.88	0.28	0.52	0.57	1.19	0.82

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

Specific combining ability (SCA) effects

Specific combining ability effects $\hat{s}_{ij}$ for the F_1 crosses for the studied traits in the combined analysis are presented in (Table 6).

For plant height, ten crosses expressed significant and positive ŝij effects. Moreover, the crosses P_1xP_2 and P_2 x P_4 gave the most desirable ŝij effects for plant height. However, nine cross combinations gave significant and negative ŝij effects for the mention trait. For No of spikelets/ spike, seven crosses in the combined analysis expressed significant and positive ŝij effects. Moreover, the cross P_4 x P_8 gave the most desirable ŝij effects for this trait. For number of spikes/ plant, four crosses expressed significant and positive ŝij effects. However, the best ŝij effects (1.62**) were detected for the cross P_4 x P_6. Regarding 1000-kernel weight, twelve cross combinations expressed significant and positive ŝij effects. The cross P2xP7 being the highest one in this traits and recorded 7.26**. Thirteen cross combinations exhibited significant and positive ŝij effects for biological yield/ plant. The best positive ŝij effects was the cross P_2 x P_7 in the combined analysis (Table 6). Regarding to grain yield/ plant, ten crosses (P_1xP_6, P_1xP_7, P_2xP_6, P_2xP_7, P_3xP_4, P_3xP_8, P_4xP_5, P_4xP_6, P_5xP_7 and P_6xP_8) exhibited significant and positive ŝij effects.

It could be concluded that the previous cross combinations might be of interest in breeding programs towards the development of pure lines varieties for high biological, and grain yields/ plant under drought conditions.

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

Cross combinations	Plant height	Number of spikelets/ spike	Number of spike / plant	1000-kernel weight	Biological yield/ plant	Grain weight / plant
P_1xP_2	8.49**	0.15	-1.25*	4.44**	-6.20**	-5.03**
P_1xP_3	-7.16**	0.42	0.73	2.03**	32.71**	1.66
P_1xP_4	-1.91	0.07	-0.13	5.63**	-21.05**	-4.17**
P_1xP_5	2.52*	0.53	0.83	-4.30**	-16.44**	-0.23
P_1xP_6	-1.13	-0.34	-0.58	-1.35*	12.18**	3.36**
P_1xP_7	0.87	-1.05**	-0.23	1.21	12.35**	4.93**
P_1xP_8	-0.98	-1.03**	-0.70	-7.99**	15.73**	-0.62
P_2xP_3	4.02**	-1.18**	1.48**	-4.44**	-1.69	0.89
P_2xP_4	8.77**	1.04**	0.45	-6.76**	-1.45	-3.34**
P_2xP_5	-4.96**	0.36	1.58**	-1.08	34.66**	-0.74
P_2xP_6	-4.11**	-2.47**	1.33*	-10.37**	-12.72**	1.80*
P_2xP_7	4.22**	-0.12	-0.82	7.26**	48.28**	3.04**
P_2xP_8	-17.79**	0.46	-0.12	6.40**	-13.00**	1.32
P_3xP_4	5.79**	0.27	-0.23	-2.99**	29.63**	4.58**
P_3xP_5	-0.28	-0.06	0.90	-1.36*	-8.92**	-7.24**
P_3xP_6	-7.26**	0.73*	-1.68**	5.96**	-18.47**	-8.92**
P_3xP_7	-6.76**	1.22**	0.00	2.33**	19.86**	0.05
P_3xP_8	-0.11	-0.17	-1.13*	-3.26**	2.75*	4.22**
P_4xP_5	-2.69**	1.01**	-0.97	1.00	-2.02	3.24**
P_4xP_6	-2.84**	0.85**	1.62**	3.67**	5.93**	3.46**
P_4xP_7	-6.01**	-0.20	0.30	-5.27**	-46.90**	-4.19**
P_4xP_8	-1.53	1.25**	-0.17	6.04**	-18.85**	-6.25**
P_5xP_6	1.59	1.03**	-0.42	3.50**	36.88**	-0.33
P_5xP_7	2.42*	-1.64**	0.77	1.40*	-58.95**	4.02**
P_5xP_8	1.24	-1.23**	0.63	0.55	10.60**	-0.14
P_6xP_7	2.11*	-1.04**	0.02	5.38**	-4.00**	-5.64**
P_6xP_8	2.42*	-0.03	-0.62	-7.59**	-10.12**	4.96**
P_7xP_8	6.26**	0.60	-1.10	-7.58**	17.38**	-1.90*
LSD5%(sij)	1.93	0.62	1.13	1.24	2.61	1.78
LSD1%(sij)	2.53	0.81	1.48	1.63	3.42	2.34
LSD5%(sij-sik)	2.86	0.91	1.67	1.83	3.86	2.64
LSD1%(sij-sik)	3.75	1.20	2.19	2.41	5.06	3.46
LSD5%(sij-skL)	0.95	0.30	0.56	0.61	1.29	0.88
LSD1%(sij-skL)	1.25	0.40	0.73	0.80	1.69	1.15

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

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استخدام التهجين التبادلى لتقدير القدرة على التالف و قوة الهجين فى القمح النامى تحت معاملات الجفاف و الرى العادى

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لدراسة قوة الهجين والقدرة علي التآلف لصفات المحصول ومكوناته لثمانية آباء من القمح بالأضافة إلي 28 هجين ناتجة منها بنظام Half diallel وذلك في محطة تجارب بحوث كلية زراعة مشتهر جامعة بنها، حيث تم عمل تجربتين بمزرعة الكلية. في التجربة الأولي تم الري مرة واحدة بعد رية الزراعة بينما التجربة الثانية تم إجراء معاملات الري الطبيعية ، دونت البيانات علي عشرة نباتات فردية أخذت عشوائيا من كل قطعة تجريبية وقدرت قوة الهجين لصفة محصول الحبوب للنبات كنسبة مئوية لإنحراف قيمة الهجين عن قيمة متوسط الأبوين أو قيمة الأب الأفضل. وتم تحليل البيانات باستخدام طريقة الهجن التبادلية (جرفنج 1956) الطريقة الثانية الموديل الأول . وكانت الصفات المدروسة هي : طول النبات (سم) – عدد السنيبلات بالسنبلة – عدد سنابل النبات – وزن 1000 حبه –المحصول البيولوجى –محصول الحبوب/ نبات (جم). كان التباين الراجع للتراكيب الوراثية الآباء والهجن والتفاعل بين الآباء والهجن معنويا لكل الصفات المدروسة تحت ظروف التحليل المشترك.

أظهرت كلا من الآباء رقم 3 و 6 أعلي قيم لصفات طول النبات ، و الاب 2 لصفه عدد السنيبلات بالسنبلة، الاب 1 لصفة عدد السنابل / النبات ، و الاب 8 لصفة وزن الـ1000 حبة ، و الاب 5 لصفة المحصول البيولوجى/ نبات والاب 8 لصفة محصول حبوب النبات الفردي علي التوالي .كما أظهر الهجين P_2xP_5أعلي قيم لصفة المحصول البيولوجى للنبات و الهجين P_6xP_8 لصفة محصول الحبوب للنبات. كان التباين الراجع للقدرة العامة والخاصة علي التآلف معنويا للصفات تحت الدراسة . كانت النسبة بين القدرة العامة/القدرة الخاصة أقل من الوحدة للصفات تحت الدراسة فى كل من معاملتى الرى و التحليل المشترك لمعظم الصفات. بينما كانت النسبة اكبر ون الوحدة لصفة محصول الحبوب/ نبات. وأظهر الاب الاول لصفات ارتفاع النبات ، عدد السنابل للنبات، ووزن 1000– حبة والمحصول البيولوجى للنبات والاب رقم 4 لوزن الالف حبة و محصول حبوب النبات و الاب رقم 8 للمحصول البيولوجى و الحبوب للنبات قدرة عامة علي التآلف.أظهرت الهجن 1 x 6، 1 x 7، 2 x 7، 3 x 4، 3 x 8، 4 x 5، 4 x 6، 5 x 7و 6 x 8 بالنسبة لصفة محصول النبات الفردي قدرة خاصة علي التآلف معنوية.