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COMBINING ABILITY FOR EARLINESS AND YIELD AND SOME OF ITS COMPONENTS IN BREAD WHEAT UNDER FAVOURABLE AND DROUGHT STRESS CONDITIONS.

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ABSTRACT

Six wheat cultivars and their all half diallel possible cross combinations were used to estimate general and specific combining ability for earliness and yield components under favorable (F) and drought stress (S) conditions. Drought stress conditions caused reduction in the F_1 hybrids average about 5.56%; 17.12%; 7.16% and 18.71% for heading date; number of spikes per plant; 1000 grain weight and grain yield per plant, respectively. Estimates of drought susceptibility index (DSI) based on grain yield per plant showed that Giza 164(P_5) and the cross combinations including (P_1 x P_5; P_2 x P_3; P_3 x P_5; P_4 x P_5 and P_5 x P_6) gave susceptibility index (DSI) values less than the unity, indicating that these genotypes were relatively tolerant to drought stress. Correlation coefficients between drought stress susceptibility index (DSI) and each of grain yield per plant and heading date were - 0.15 and 0.16, respectively. The results showed that mean squares due to genotype x environment interaction were highly significant, suggesting a differential response of the genotypes under favorable (F) and drought stress (S) environments. The results indicated that GCA and SCA mean squares were highly significant for all studied traits under each environment and their combined data. The interactions of GCA x E and SCA x E mean squares were found to be highly significant for all studied traits except SCA x E in grain yield per plant, Moreover, the ratio of GCA x E /SCA x E was more than one for all studied traits, revealing that non additive genetic effects are more stable over the environments than additive ones. Estimates of general combining ability effects exhibited that Gemmeiza 3 (P_1) was excellent general combiner for earliness under the two environments. For yield components, Gemmeiza 3 (P_1), Giza 164 (P_5) and Gemmeiza 7 (P_6) were considered the best parents under both environments. The results indicated that the crosses (P_2 x P_5) and (P_4 x P_6) under favorable conditions as well as (P_1 x P_2) and (P_3 x P_4) under stress conditions exhibited significant SCA effects for earliness. The crosses (P_3 x P_4) and (P_4 x P_6) revealed significant SCA effects for number of spikes per plant under the two environments. Desirable SCA effects for 1000 grain weight were obtained by the cross (P_2 x P_3) under each of the two environments. Concerning grain yield per plant, the cross (P_1 x P_3) was the most promising under the two environments. While, the cross (P_5 x P_6) exhibited desirable SCA effect for the same trait under drought stress conditions. It is interesting to note that the promising crosses which showed desirable SCA effects were also significantly earlier and higher yield than their mid and better parents under the two environments. Generally, estimates of GCA and SCA in these promising populations proved that selection for drought tolerance could be effective in early segregating generations.

INTRODUCTION

Drought is a major stress factor limiting wheat production in Egypt as in many areas of the world. Thus, developing of drought tolerant cultivars in wheat is an important goal for wheat breeders in this area. Combining ability studies are frequently used to evaluate and identify genotypes that yield well under drought. Therefore, it is necessary to assess combining ability and combining ability x environment interaction for yield and its components to ensure better prediction and gain under selection.

Several investigators studied GCA and SCA and their interaction with environments for earliness, grain yield and its components. For instance, El-Sherbeny (1999); Sharma *et al* (2002); Darwish (2003); El-Seidy (2003) and Bayoumi (2004) reported that the interactions of GCA x E and SCA x E mean squares were significant for earliness and yield components, suggesting that the magnitude of additive and non additive gene fluctuated from favorable to drought stress conditions. Dhanda and Sethi (1996); Sharma and Tandon (1997); Joshi *et al* (2002) and El-Sherbeny (2004) stated that the ratio of GCA x E /SCA x E was more than one for earliness and yield components, revealing that non additive genetic effects are more stable over the environments than additive ones.

The correlation coefficient between drought susceptibility index (DSI) with grain yield per plant and heading date were studied by many authors. Kheiralla (1994); Sharma and Bhargava (1996); Kheiralla *et al* (1997) and El-Sherbeny (1999) found that drought susceptibility index (DSI) was positively and negatively correlated with heading date and grain yield per plant, respectively. The present study was carried out to estimate the relative importance of general and specific combining ability for earliness and yield components under favorable and drought stress. Drought susceptible index (DSI) for all genotypes and its correlations with grain yield and heading date was also estimated.

MATERIALS AND METHODS

The present investigation was undertaken at the Experimental Research Farm of Sohag Faculty of Agriculture, South Valley University. Six bread wheat cultivars (*Triticum aestivum L.*) representing a wide range of diversity were used in this study as parents. These parents are: Gemmeiza 3 (P_1), Sakha 8 (P_2), Giza 168 (P_3), Sakha 69 (P_4), Giza 164 (P_5) and Gemmeiza 7 (P_6).

In 2003/2004 season, the six parents were crossed in all possible combinations excluding reciprocals to produce 15 F_1 hybrids. All parental genotypes were also self pollinated to increase seeds from each one.

In 2004/2005 season, seeds of the six parents and their 15 F_1 hybrids were evaluated under two separate irrigation regime experiments. The first experiment was irrigated at all growth stages (favourable conditions). In the second experiment (drought stressed conditions), two irrigations were skipped; one at tillering stage and another at spike initiation stage.

In each experiment, the parents and their 15 F_1 hybrids were sown in a randomized complete block design with three replications. Each replicate contained 21 plots. Each plot consisted of one row with 3 m long and 20 cm apart between rows. Plants were spaced by 10 cm within row. All recommended cultural practices were applied in the two environments.

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

In each environment, data were subjected to the analysis of variance in order to test the significance of the differences among the 21 genotypes (six parents and their 15 F_1 hybrids) according to Cochran and Cox (1957). Combined data over the two environments were also subjected to the combined analysis of variance in order to test the interaction of genotypes with environments.

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

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

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

Where:

Y_d = mean yield in stress environment.

Y_p = mean yield in non stress environment.

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

RESULTS AND DISCUSSION

Genotypic variations

The analysis of variance of the two experiments and their combined data for all studied traits are presented in Table 1. Mean squares of environments were found to be highly significant for all studied traits with overall means of favourable environment higher than those of drought stress conditions. The differences among genotypes under each environment and its combined data were highly significant for all studied traits. Moreover, mean squares of genotype x environment interaction were highly significant, suggesting a differential response of the genotypes under favourable (F) and drought stress (S) environments. Similar results were obtained by El-Sherbeny (1999); Sheikh *et al.* (2000); Singh (2002) ; Joshi *et al*, (2002) and Bayoumi (2004).

Table 1: Analysis of variance and mean squares of the six parents and their F_1 hybrids for all studied traits under favorable environment (F) and drought stress environment (S) as well as their combined data

S.V	D.F		Heading date			No. of spikes/plant			1000 grain weight			Grain yield/plant		
	S	C	F	S	C	F	S	C	F	S	C	F	S	C
Environ. (E)	-	1	-	-	753.39	-	-	41.12	-	-	386.92	-	-	1070.12
Reps/E	2	4	5.42	3.36	4.39	0.32	0.41	0.37	6.11	4.58	5.35	3.89	2.56	3.23
Genotypes (G)	20	20	21.50**	15.47**	20.93**	2.51**	2.23**	3.04**	60.59**	43.92**	64.09**	48.79**	25.54**	45.30**
GxE	-	20	-	-	16.04**	-	-	1.73**	-	-	40.42**	-	-	29.03**
Error	40	80	3.96	4.23	4.10	0.19	0.34	0.26	4.32	6.72	5.52	5.51	6.28	5.89

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

Performances of parents and their crosses

The mean performances of the six parents and their 15 F_1 crosses for all studied traits are given in Table 2. The results indicated that the mean performances of all genotypes were variable from favorable to drought conditions. Drought stress conditions caused reduction about 6.28%; 23.25%; 7.57% and 6.88% in parental average for heading date; number of spikes per plant; 1000 grain weight and grain yield per plant, respectively. While, reduction in the F_1 hybrids average was 5.56%; 17.12%; 7.16% and 18.71% for heading date; number of spikes per plant; 1000 grain weight and grain yield per plant, respectively.

The results indicated that Gemmeiza 3 (P1) was found to be the earliest parent under both environments. In both environments, Gemmeiza 3 (P1) and Gemmeiza 7 (P6) were found to be the best parents for number of spikes per plant, 1000 grain weight and grain yield per plant, respectively. Regarding the F1 hybrids, the cross combinations (P1xP3), (P3xP4) and (P4xP6) at normal conditions as well as (P1xP2), (P1xP5), (P2xP5) and (P3xP4) at drought stress conditions were the earliest hybrids. The crosses (P1xP5), (P1xP6), (P4xP6) and (P5xP6) were the highest hybrids in number of spikes per plant under both the two environments. For 1000 grain weight, the crosses (P1xP4), (P1xP5), (P1xP6) and (P5xP6) under the two environments were the most promising hybrids. The crosses (P1xP4), (P1xP6), (P3xP6) and (P4xP6) were the best yielding hybrids under favorable environments. While, the crosses (P1xP5), (P3xP6), (P4xP6) and (P5xP6) were the most promising hybrids for grain yield per plant at drought stress conditions.

Drought susceptibility index (DSI)

The estimates of drought susceptibility index (DSI) based on grain yield per plant are presented in Table 2. The results showed that Giza 164(P_5) was drought stress tolerant parent. On the other hand, other parents were susceptible to drought stress. Concerning the F_1 hybrids, (P_1xP_5), (P_2xP_3), (P_3xP_5), (P_4xP_5) and (P_5xP_6) crosses were relatively tolerant to drought stress. Whereas the other hybrids were susceptible to drought stress.

In general, it could be noticed that all cross combinations including Giza 164 (P_5) gave (DSI) values less than the unity. These results indicate that the tolerant parent Giza 164 (P_5) transmitted its genes controlling drought tolerance. In addition, the crosses (P_1xP_5), and (P_5xP_6) gave the highest yield under drought stress conditions with drought susceptibility index (DSI) less than unity. Therefore, these crosses could be considered as promising populations for isolating useful segregates to be cultivated under drought stress conditions. The correlation coefficients between drought susceptibility index (DSI) and each of grain yield per plant and heading date were also estimated. Grain yield per plant under drought stress conditions was negatively correlated with drought susceptibility index ($r = -0.15$). This indicates that grain yield per plant was the most variable trait for selection under heat stress conditions. On the other hand, heading date was positively correlated with (DSI) values ($r = 0.16$), suggesting that early genotypes were less susceptible to drought stress than late ones. These results are in accordance with those reported by Kheiralla (1994); Sharma and Bhargava (1996); Kheiralla *et al* (1997) and El-Sherbeny (1999).

Table 2: Mean performance of the six parents and their F_1 hybrids for studies traits under favourable (F) and drought stress (S) conditions as well as their combined data (C) in addition to the estimates of drought susceptibility index (DSI).

Genotypes	Heading date		No. of spikes/plant		1000-grain weight		Grain yield/ plant		DSI
	F	S	F	S	F	S	F	S	
Gemmeiza 3 (P_1)	82.1	78.4	6.42	4.56	54.6	49.4	31.5	21.8	1.63
Sakha 8 (P_2)	91.4	83.6	3.65	2.72	36.8	34.6	20.6	16.4	1.05
Giza 168 (P_3)	87.2	82.5	4.73	6.64	40.3	36.5	25.7	20.8	1.00
Sakha 69 (P_4)	85.6	81.3	5.56	4.38	44.5	41.2	29.1	22.6	1.16
Giza 164 (P_5)	90.5	80.8	6.81	5.77	49.4	46.8	24.4	23.5	0.21
Gemmeiza 7 (P_6)	88.3	85.1	7.12	5.26	51.7	47.6	34.5	25.7	1.32
Parents mean	87.5	82.0	5.72	4.39	46.2	42.7	27.6	25.7	
$P_1 \times P_2$	84.5	77.1	5.86	5.02	49.3	47.1	29.7	23.6	1.05
$P_1 \times P_3$	81.2	78.0	6.13	4.66	47.6	46.8	33.4	26.2	1.13
$P_1 \times P_4$	82.8	79.6	6.64	4.69	52.5	46.2	34.9	25.8	1.37
$P_1 \times P_5$	84.4	76.2	7.05	6.08	52.8	47.7	32.1	27.5	0.74
$P_1 \times P_6$	83.3	80.5	7.24	5.31	54.9	46.5	35.4	25.3	1.47
$P_2 \times P_3$	86.6	79.7	5.06	4.01	45.6	44.6	24.8	20.5	0.89
$P_2 \times P_4$	87.1	83.4	5.01	3.96	44.9	41.7	28.7	22.8	1.05
$P_2 \times P_5$	85.8	78.6	5.82	5.13	46.8	45.5	26.3	24.4	0.37
$P_2 \times P_6$	86.2	82.5	6.02	5.16	49.7	43.6	29.7	23.7	1.05
$P_3 \times P_4$	82.5	78.2	6.36	5.04	45.4	40.8	31.2	25.3	0.99
$P_3 \times P_5$	85.3	79.6	5.89	5.54	46.2	44.5	27.5	23.6	0.74
$P_3 \times P_6$	84.5	81.1	6.14	5.22	48.4	44.4	33.8	26.5	1.10
$P_4 \times P_5$	84.1	82.6	6.58	5.78	50.9	46.3	30.3	25.4	0.84
$P_4 \times P_6$	82.2	80.5	7.29	5.96	46.4	45.7	34.8	27.6	1.08
$P_5 \times P_6$	86.7	79.8	6.66	6.09	51.8	49.4	32.6	29.8	0.45
Hybrids mean	84.5	79.8	6.25	5.18	48.9	45.4	31.0	25.2	
LSD 5%	3.27	3.39	0.71	0.95	3.43	4.28	3.88	4.12	
LSD 1%	4.37	4.54	0.95	1.27	4.59	5.72	5.18	5.51	
R % P	6.28		23.25		7.57		6.88		
R % F_1	5.56		17.12		7.16		18.71		

R% : Percentage of reduction due to drought stress.
: ($M.P_{D1} - M.P_{D2} / M.P_{D1}$) x 100.
: ($M.F_{1D1} - M.F_{1D2} / M.F_{1D1}$) x 100.

Estimates of heterosis

Estimates of heterosis over mid and better parent for all studied traits at favourable and drought stress conditions are shown in Table 3. The results indicated that ten and eight out of 15 crosses were significantly flowered earlier than their mid parents with the maximum negative heterosis values of –5.66% (P_2xP_5) and –4.81% (P_1xP_2) under non stress and drought stress conditions, respectively. Compared to earlier parent, the crosses (P_2xP_5) and (P_3xP_4) exhibited high significant useful heterosis values of –5.19% and –3.39% under favourable and stress conditions, respectively.

Concerning number of spikes per plant, 14 and 15 out of 15 crosses showed positive significant heterosis values relative to mid parents ranged from 2.08% to 23.49% and 4.92% to 37.91% under non stress and drought stress conditions, respectively. For better parent, six and seven out of 15 crosses revealed positive significant heterosis values under normal and stress environments, respectively. The cross combination (P_3xP_4) gave the maximum useful values of 14.39% and 15.07% at favourable and stress conditions, respectively.

Regarding 1000 grain weight, 12 and 11 out of 15 crosses were significantly heavier than their mid parents under non stress and drought stress conditions, respectively. The cross (P2xP3) exhibited the largest useful heterosis values of 18.29% and 25.46% under normal and stress environments, respectively. Compared to the better parent, the cross (P_2xP_3) showed also the maximum heterosis values of 13.15% and 22.19% under favourable and stress conditions, respectively.

With respect to grain yield per plant, all crosses were significantly better in yield than their mid parents under the two environments. The cross combinations (P_1xP_3) and (P_2xP_5) revealed the largest heterosis values of 16.78% and 16.89% under normal and drought stress conditions, respectively.

Table 3: Estimates of heterosis over mid parents (above) and better parent (below) for all studied traits under favourable (F) and drought stress (S) conditions.

Crosses	Heading date		No. spikes/plant		1000grain weight		Grain yield/plant	
	F	S	F	S	F	S	F	S
	-2.59	-4.81**	16.27**	37.91**	7.88**	12.14**	14.01**	23.56**
P_1xP_2	2.92	-1.66	-8.72**	10.09**	-9.71**	-4.65*	-5.71**	8.25**
	-4.07**	-2.55	9.86**	13.66**	0.32	8.96**	16.78**	23.00**
P_1xP_3	-1.09	-0.51	-4.52**	2.19**	-12.82**	-5.26**	6.03**	20.18**
	-1.25	-0.31	10.85**	4.92**	5.95**	1.99	15.18**	16.22**
P_1xP_4	0.85	1.53	3.43**	2.85**	-3.85*	-6.48**	10.79**	14.16**
	-2.20	-4.27**	6.49**	17.60**	1.54	-0.83	14.85**	21.41**
P_1xP_5	2.80	-2.81	3.52**	5.37**	-3.30	-3.44	1.90	17.02**
	-2.23	-1.53	6.94**	8.15**	3.29*	-4.12*	7.27**	6.53**
P_1xP_6	1.46	2.68	1.68**	0.95	0.55	-5.87**	2.61	-1.56
	-3.02*	-4.03**	20.76**	26.10**	18.29**	25.46**	7.13**	10.21**
P_2xP_3	-0.69	-3.39*	6.98**	10.16**	13.15**	22.19**	-3.50	-1.44
	-1.58	1.15	8.68**	11.55**	10.46**	10.03**	15.49**	15.90**
P_2xP_4	1.75	2.58	-9.89**	-9.59**	0.90	1.21	-1.37	0.88
	-5.66**	-4.38**	11.28**	20.70**	8.58**	11.79**	16.89**	22.30**
P_2xP_5	-5.19**	-2.72	-14.54**	-11.09**	-5.26**	-2.78	7.79**	3.83
	-4.06**	-2.19	11.69**	29.32**	12.32**	6.08**	7.80**	12.59**
P_2xP_6	-2.38	-1.32	-15.45**	-1.90	-3.87*	-8.40**	-13.91**	-7.78**
	-4.51**	-4.52**	23.49**	25.69**	7.07**	5.02*	13.87**	16.59**
P_3xP_4	-3.62*	-3.81*	14.39**	15.07**	2.02	-0.97	7.22**	11.95**
	-3.99**	-2.51	2.08**	17.62**	3.01*	6.84**	9.78**	6.55**
P_3xP_5	-2.18	-1.49	-13.51**	-3.99**	-6.48**	-4.91*	7.00**	0.42
	-3.70*	-3.22*	3.72**	18.20**	5.22**	5.59**	12.29**	13.98**
P_3xP_6	-3.09*	-1.69	-13.76**	-0.76	-6.38**	-6.72**	-2.03	3.11
	-4.49**	1.91	6.30**	13.78**	8.41**	5.23**	13.27**	10.19**
P_4xP_5	-1.75	2.23	-3.38**	0.17	3.03	-1.07	4.12*	8.09**
	-5.46**	-3.25*	14.98**	23.65**	-3.53*	2.93	9.43**	14.28**
P_4xP_6	-3.97*	-0.98	2.39**	13.31**	-10.25**	-3.99	0.87	7.39**
P_5xP_6	-3.02*	-3.80*	-4.45**	10.33**	7.69**	4.66**	10.70**	21.14**
	-1.81	-1.24	-6.46**	5.54**	0.19	3.78	-5.51**	15.95**

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

While, the crosses (P_1xP_2), (P_1xP_3), (P_1xP_5), (P_2xP_5) and (P_5xP_6) were the most promising hybrids under drought stress conditions with heterosis values of 23.56%, 23.00%, 21.41%, 22.30% and 21.14%, respectively. As for the better parent heterosis values for six and eight out 15 crosses had significant values under favorable and drought stress conditions, respectively. The crosses (P_1xP_3), (P_1xP_4), (P_1xP_5) and (P_5xP_6) showed the best heterosis values of 20.18%, 14.16%, 17.02% and 15.95%, respectively, under drought stress conditions.

Generally, these results indicated that the majority of crosses were significantly earlier and higher in yield than their mid and better parents under the two environments. This finding reflects the important role of non additive gene action in the inheritance of these traits.

Combining ability analysis

Results of combining ability analysis in Table 4 showed that both GCA and SCA mean squares were highly significant for all studied traits under each condition and their combined data. This indicates that all types of gene action are involved in the inheritance of these traits. In addition, the ratio of GCA/SCA was found to be greater than unity for all studied traits under both environments, indicating that additive gene action played a major role in the expression of these traits.

The interactions of GCA x E and SCA x E mean squares were found to be highly significant for all studied traits except SCA x E in grain yield per plant, suggesting that the magnitude of all types of gene action fluctuated from favourable to drought stress conditions. Moreover, the ratio of GCA x E /SCA x E was more than one for all studied traits, revealing that non additive genetic effects are more stable over the environments than additive ones. Therefore, selection for these traits under more environments would be effective to improve these traits. In this trend, similar findings were reported by El-Sherbeny (1999); Joshi *et al* (2002); El-Seidy (2003); Bayoumi (2004) and El-Sherbeny (2004).

GCA effects (g_i)

Estimates of general combining ability of each parent (gi) for all studied traits under the two environments are presented in Table 5. The results showed that Gemmeiza 3 (P_1) was excellent general combiner for earliness under the two environments. Moreover, Sakha 69 (P_4) seemed to be a good general combiner for earliness under non stress conditions. For yield components, Gemmeiza 3 (P_1), Giza 164 (P_5) and Gemmeiza 7 (P_6) were considered to be the best parents under both environments. Whereas, Sakha 8 (P_2) and Giza 168 (P_3) were the poorest general combiners for these traits under the two environments. Consequently, the previous parents which exhibited useful general combining ability effects, could be utilized in breeding programs to improve earliness and yield components under non stress and drought stress conditions.

Table 4: Combining ability analysis of variance for all studied traits under favorable (F) and drought stress (S) conditions as well as their combined data

SV	DF		Heading date			No. of spikes/plant			1000 grain weight			Grain yield/plant		
	S	C	F	S	C	F	S	C	F	S	C	F	S	C
GCA	5	5	13.49**	7.23**	11.66**	1.94**	1.34**	2.04**	40.23**	26.13**	30.22**	53.49**	20.29**	39.92**
SCA	15	15	5.06**	4.46**	5.42**	0.47**	0.55**	0.67**	13.51**	10.82**	18.41**	3.85*	4.58*	6.83**
GCA x E	-	5	-	-	9.06**	-	-	1.24**	-	-	36.14**	-	-	33.86**
SCA x E	-	15	-	-	4.10**	-	-	0.35**	-	-	5.92**	-	-	1.62
Error	40	80	1.62	1.41	1.37	0.06	0.11	0.09	1.44	2.24	1.84	1.84	2.09	1.96
GCA/SCA	-	-	2.67	1.62	2.15	4.13	2.44	3.04	2.98	2.41	1.64	13.89	4.43	5.84
GCAxE/SCAxE	-	-	-	-	2.21	-	-	3.54	-	-	6.10	-	-	20.90

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

Table 5: Estimates of general combining ability effects(gi) of each parent for all studied traits under favourable (F) and drought stress (S) conditions.

Parents	Heading date		No. spikes/plant		1000grain weight		Grain yield/plant	
	F	S	F	S	F	S	F	S
Gemmeiza 3 (P_1)	-2.13**	-1.82*	0.39**	0.03	3.68**	2.60**	2.27**	0.31
Sakha 8 (P_2)	1.95**	0.67	-0.95**	-0.74**	-3.37**	-2.58**	-3.74**	-2.74**
Giza 168 (P_3)	-0.38	-0.15	-0.46**	-0.36**	-2.88**	-2.28**	-1.03*	-0.73
Sakha 69 (P_4)	-0.94*	0.47	0.04	-0.06	-0.97*	-1.15*	0.97*	0.30
Giza 164 (P_5)	1.24**	-0.60	0.37**	0.69**	1.31**	1.34**	-1.59**	1.02*
Gemmeiza 7 (P_6)	0.25	1.43*	0.61**	0.45**	2.22**	1.56**	3.12**	1.85**
SE (gi)	0.37	0.38	0.08	0.11	0.39	0.48	0.44	0.47

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

SCA effects (S_{ij})

Estimates of SCA effects (S_{ij}) of each cross for all studied traits at the two environments are given in Table 6. The results indicated that the crosses (P_2xP_5) and (P_4xP_6) under favorable conditions as well as (P_1xP_2) and (P_3xP_4) under stress conditions, which resulted from crossing (good x poor) general combiners, exhibited significant SCA effects for earliness. The cross (P_3xP_4) involving two poor general combiners and the cross (P_4xP_6) resulting from (poor x good) general combiners, revealed significant SCA effects for number of spikes per plant under the two environments. Desirable SCA effects for 1000 grain weight were obtained in the cross (P_2xP_3), which include two poor general combiners under each of the two environments. In addition, the two crosses (P_2xP_6) and (P_4xP_5) which included one poor and one good general combiners, showed desirable SCA effects for the same trait under normal environment. Concerning grain yield per plant, the cross (P_1xP_3), which resulted from crossing (good x poor) general combiners, was the most promising under the two environments. While, the cross (P_5xP_6), involving two good combiners, exhibited desirable SCA effect for the same trait under drought stress conditions.

It is interesting to note that the promising crosses which showed desirable SCA effects exhibited (as previously mentioned) high heterosis values for these studied traits. It could be also observed that the excellent cross combinations in this study were obtained from (good x good), (good x poor) and (poor x poor) general combiners. Therefore, it is not necessary that parents having estimates of GCA effects would also give high estimates of SCA effects in their respective cross combinations. Similar results were obtained by Sheikh *et al.* (2000); Singh (2002); Joshi *et al*, (2002) and El-Sherbeny (2004).

It could be concluded that the tolerant parent Giza 164 (P_5) transmitted its genes controlling drought tolerance to the cross combinations including it ($P_1 \times P_5$; $P_3 \times P_5$; $P_4 \times P_5$ and $P_5 \times P_6$). Drought susceptibility index (DSI) was positively correlated with heading date, suggesting that early genotypes were less susceptible to drought stress than late ones. Consequently, these crosses could be considered promising populations for isolating useful segregates to be cultivated under drought stress conditions. Estimates of GCA and SCA in these promising populations under favorable and drought stress conditions proved that selection for drought tolerance could be effective in early segregating generations.

Table 6: Estimates of specific combining ability effects (Sij) of each cross for all studied traits under favorable (F) and drought stress (S) conditions.

Crosses	Heading date		No. spikes/plant		1000grain weight		Grain yield/plant	
	F	S	F	S	F	S	F	S
P_1xP_2	-0.67	-2.20*	0.33	0.79**	0.87	2.46	1.12	1.81
P_1xP_3	-1.64	-0.09	0.10	0.05	-1.32	1.86	2.91*	3.40*
P_1xP_4	0.52	0.50	0.11	-0.22	1.66	0.13	1.60	0.97
P_1xP_5	-0.05	-1.84	0.20	0.42	-0.31	-1.35	1.37	1.95
P_1xP_6	0.93	0.44	0.14	-0.12	0.88	-2.28	-0.05	-1.08
P_2xP_3	-0.32	-1.27	0.37	0.17	3.73**	4.83**	-0.48	-0.25
P_2xP_4	0.75	1.81	-0.18	-0.19	1.11	0.81	1.42	0.82
P_2xP_5	-2.73*	-1.92	0.30	0.24	0.74	1.62	1.58	1.90
P_2xP_6	-1.34	-0.05	0.26	0.50	2.73*	0.01	0.27	0.37
P_3xP_4	-1.53	-2.57*	0.67**	0.71*	1.13	-0.39	1.20	1.51
P_3xP_5	-0.90	-0.11	-0.12	0.27	-0.35	0.32	0.07	-0.92
P_3xP_6	-0.82	-0.64	-0.12	0.22	0.94	0.50	1.68	1.16
P_4xP_5	-1.54	2.28*	0.07	0.21	2.44*	1.00	0.87	-0.14
P_4xP_6	-2.45*	-1.85	0.54*	0.62*	-2.97**	0.67	0.65	1.23
P_5xP_6	-0.13	-1.49	-0.42	0.01	0.15	1.38	1.02	2.71*
SE (Sij)	1.02	1.05	0.22	0.29	1.06	1.32	1.20	1.28

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

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القدرة علي التآلف لصفات التزهير و المحصول وبعض مكوناته تحت الظـروف العادية والجفاف في قمح الخبز

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تم إجراء هذا البحث لدراسة السلوك الوراثي لصفات التزهير ومكونات المحصول وذلك باستخدام نظام التهجين النصف دائري بين ستة أصناف من قمح الخبز تحت الظروف الملائمة وظروف الجفاف .

ويمكن تلخيص أهم النتائج فيما يلي:

- أدت ظروف الجفاف إلي نقص في عدد الأيام حتى التزهير وعدد السنابل للنبات الواحد ووزن الـ١٠٠٠ حبة ومحصول حبوب النبات الواحد في هجن الجيل الأول بمقدار ٥,٥٦%، ١٧,١٢%، ٧,١٦%، ١٨,٧١% علي الترتيب.
- أظهرت النتائج أن قيم معامل الحساسية(الإصابة) للجفاف للهجن التي يشترك فيها الأب جيزة ١٦٤(P_5) كانت أقل من الوحدة، لذا فإنها تعتبر مقاومة لظروف الجفاف. كما أظهر معامل الحساسية(الإصابة) للجفاف ارتباطا موجبا (٠,١٦) مع ميعاد التزهير وارتباطا سالبا(-٠,١٥) مع محصول حبوب النبات.
- كان التفاعل بين التراكيب الوراثية والبيئة معنويا وهذا يدل علي اختلاف سلوك التراكيب الوراثية المستخدمة في الدراسة من بيئة إلي أخرى.
- كان متوسط مربعات القدرة العامة (GCA) والخاصة (SCA) علي التآلف معنويا لكل الصفات المدروسة في كلتا البيئتين والتحليل المشترك لهما. كما كان التفاعل بين البيئة وكل من القدرة العامة (GCAxE) والخاصة (SCAxE) علي التآلف معنويا لكل الصفات المدروسة.
- أوضحت النتائج أن الأب جميزة ٣ (P_1) ذا قدرة عامة عالية علي التآلف لصفة التزهير، كما كانت الآباء جميزة ٣ (P_1)، جيزة ١٦٤ (P_5)، جميزة ٧ (P_6) ذات قدرة عامة عالية علي التآلف لصفات المحصول في كلتا البيئتين.
- أوضحت النتائج أن الهجن (P_2xP_5)، (P_4xP_6) تحت الظروف العادية والهجن ($P_1x P_2$)، ($P_3x P_4$) تحت ظروف الجفاف كانت لها قدرة خاصة علي التالف لصفة التزهير. بينما أظهرت الهجن ($P_4 x P_6$)، ($P_3 x P_4$) تحت كلتا البيئتين قدرة خاصة عالية علي الإئتلاف لصفة عدد سنابل النبات الواحد. كما أظهر الهجين (P_2xP_3) تحت الظروف العادية والجفاف قدرة خاصة عالية علي التآلف لصفة وزن الألف حبة. بينما كانت للهجن ($P_1x P_3$)، ($P_5x P_6$) قدرة خاصة عالية علي التآلف لصفة محصول النبات الواحد تحت كلتا البيئتين.
- أظهرت معظم الهجن قوة هجين عالية ومعنوية بالنسبة لمتوسط الآباء ولأحسن الأبوين لكل الصفات المدروسة تحت الظروف العادية والجفاف.
- وطبقا للنتائج السابقة فإن الانتخاب للجفاف قد يكون مجديا في الأجيال الانعزالية للهجن المبشرة .