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ESTIMATES OF COMBINING ABILITY AND SUSCEPTIBILITY INDEX IN WHEAT DIALLEL CROSSES UNDER STRESS AND NORMAL IRRIGATION TREATMENTS

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ABSTRACT

Six wheat genotypes of diverse origin were crossed in half diallel Parents and their 15 F_1 hybrids were planted and irrigated one (stress) or irrigated three times (normal irrigation).Results showed that the mean performance for all genotypes were decreased under stress conditions. Highly significant effects of irrigation treatments were exhibited on all studied traits, indicating that the two irrigation regimes affected differently on these traits. Mean squares due to genotypes, genotype x environments interaction were significant for all studied traits. The best general combining ability effects for grain yield/plant and one or more of its attributes was found in the parent Giza 168, while the best general combiner for earliness was Sakha 93 under both conditions. The best specific combining ability effects for earliness were shown by the hybrid Sakha 93 x Gemmeiza 9, Onomly x Sids 1for number of kernels spike, Sids 1 x Gemmeiza 9 for 100 kernels/weight and Sakha 93 x Giza 168for grain yield/plant, under both irrigation treatments. Drought susceptibility index across the two irrigation treatments (normal and drought) indicated that for days to maturity the best parent was Sids 1, meanwhile the best cross was Onomly x Gemmeiza 9, while for grain yield/plant the best parent was Gemmeiza 9, and the best cross was Onomly x Sids 1.Mean squares due to genotypes, general and specific combining abilities of susceptibility index were highly significant for all traits except 100 kernels weight .the parent Sids 1 gave significant negative general combining ability effect for drought susceptibility index for grain yield/plant and earliness, while the parent Giza 168 gave significant negative effects for plant height and number of kernels/spike. Significant or highly significant negative specific combining ability effects for drought susceptibility index expressed in earliness were found in the crosses Giza 168 x Gemmeiza. 9, Dobary x Onomly, Dobary x Sids 1 and Onomly x Gemmeiza 9, for plant height was Giza 168 x Dobary, for number of kernels spike were Giza 168 x Gemmeiza 9 and Dobary x Sids 1 and for grain yield/plant were crosses Sakha 93 x Giza 168 and Onomly x Sids 1. It is of great interest to note that the most hybrids, which included parents Giza 168 and Dobary, were tolerant expressed in most traits, indicating the importance of these parents for this target.

Key words: ***Wheat. Diallel. Drought. Water stress. Normal irrigation. Combining ability. Drought susceptibility index.***

INTRODUCTION

Wheat is the major cereal crop in Egypt, covering one million hectares with a total annual production of 6.7 million tons in 2005/2006 (Statistical data, 2006, ARC, Giza), which satisfies about 55% of national wheat consumption. Therefore, the efforts of wheat breeders must be

continued to increase the productivity of unit area to face the gap between wheat production and consumption in Egypt.

Drought remains one of the most important factors threatening the food security of people through the world Fashedfar *et* al (1995).

Wheat production under minimum irrigation conditions become an objective in Egypt due to increasing limitations of water supply. Using yield components as a quantification and selection criteria should be superior to using yield under drought. Sadiq et al (1994) found high grain yield proved to be best indicator of drought tolerance. Nabipour et al (2002) showed that 1000-kernel weight, number of kernel / spike, grain yield and plant height decreased with drought. Darwish and EL-Hosary (2003) and Mohamed (2004) concluded that significant differences among wheat cultvars in their response to the environmental conditions and, hence their grain yield. Farhat (2005) showed that water stress treatment decreased the means of days to heading, days to maturity, plant height, grain yield and its components

The objectives of this investigation were to identify superior parents and cross combinations from 6 x 6 diallel cross of bread wheat parental genotypes grown under water deficiency, estimate combining ability and type of gene action of genotypes under normal and water stress environments, estimate of the susceptibility index (SI) for yield and some related agronomic traits and produc new genotypes of high yielding ability under normal and drought stress irrigations.

MATERIALS AND METHODS

The present investigation was performed during the two seasons 2004/2005 and 2005/2006 at the experimental Farm, Fac. of Agric., Kafr El-Sheikh University. Six parental genotypes of spring wheat were used four local wheat cultivars (Sakha 95, Giza 168, Sids 1 and Gemmeiza 9) and two Russian cultivars (Onomly and Dobary). In 2004/2005 season, the six wheat genotypes were used as parents in half diallel cross mating design and seeds of 15 F_1s were produced.

In 2005/2006,seeds of the parents and their 15 F_1 hybrids were planted in two adjacent experiments. The first experiment was irrigated one time after planting irrigation (at the tillering stage) (stress experiment). The second was irrigated three times after planting irrigation (normal irrigation). Each experiment was designed in a randomized complete black design with four replications. Each parent and F_1 was represented by two rows per replicate. Each row was 2.5 m long, spacing between rows was 20 cm with 20 cm between plants.

All the recommended agronomic practices for wheat production were applied at the proper time. Ten guarded plants were randomly sampled from each entry to collect data on heading and maturity dates, plant height

(cm), number of kernels/spike, 1000 grains weight (g), and grain yield/plant (g).

Data of yield and some related agronomic traits were used to estimate the drought susceptibility index (DSI) as suggested by Fischer and Maurer (1978) as follows:

$$DSI = \left(1 - \frac{Y_d}{Y_p}\right) / D$$

Where:

DSI = An index of drought susceptibility
Yd = Performance of a genotype under drought stress
Yp = Performance of a genotype under normal irrigation
D = Drought intensity = 1-(mean Y_d of all genotypes/mean Y_p of all genotypes).

An ordinary analysis of variance for each experiment and the combined analysis across the two experiments (stress and normal irrigation) were performed according to Snedecor and Cochran (1967), whenever homogeneity of error was detected.

Combining ability analysis was performed according to Griffing (1956) using method 2, model 1.

RESULTS AND DISCUSSION

Mean squares due to genotypes for all the studied traits under each environment (normal and stress irrigations) and their combined data are presented in Table (1).

The mean squares due to irrigations were highly significant for all the studied traits, indicating that the two irrigation regimes behaved differently for these traits. Moreover, the mean squares due to for genotypes were highly significant for all traits, except for days to maturity and plant height under normal irrigation, indicating the presence of genetic variability among the studied genotypes. This variability reflects good possibilities to improve grain yield and its related characters (using) selection. Results also showed that mean squares due to for parents and crosses were significant under all conditions, except for days to maturity and plant height under normal irrigation and combined conditions as well as 100 kernels weight under normal irrigation.

Mean squares due to of genotypes x environments, parents x environments and crosses x environments interactions were highly significant for all studied traits, except 100 kernels weight, indicating that the genotypes responded differently to water regime for these traits.

Table 1. Mean squares from analysis of variance in each experiment, from their combined analysis across two experiments and from analysis of general and specific combining ability for all studied traits.

S.O.V.	d.f.		Heading date (day)			Maturity date (day)			Plant height (cm)		
	Separate	Comb.	N	S	Comb.	N	S	Comb.	N	S	Comb.
Replicattions	3	-	6.58	1.22	-	5.85	2.81	-	24.39	2.14	-
Irrigations (I)	-	1	-	-	1482.15**	-	-	3259.52**	-	-	1722.88**
Rep. with irrig. (E_1)	-	6	-	-	3.90	-	-	4.33	-	-	13.27
Genotypes(g)	20	20	74.68**	66.04**	124.3**	20.36	46.54**	38.34**	21.56	86.49**	66.74**
Parents(p)	5	5	141.47**	128.60**	245.33*	16.87	99.14**	73.19	10.67	128.24*	88.74
Crosses(c)	14	14	56.10**	47.50**	89.59**	22.79	296.95**	28.48	26.55	58.73**	50.89
Pvs c.	1	1	0.85	12.8	3.69	3.79	15.8	2.13	6.15	266.38	178.64
Irrig. x genotypes	-	20	-	-	16.49**	-	-	28.56**	-	-	41.41**
Par. x Irrig.	-	5	-	-	24.74**	-	-	42.82**	-	-	50.17*
Crosses x Irrig.	-	14	-	-	14.01**	-	-	24.26**	-	-	34.39
Pvs.C x Irrig.	-	1	-	-	9.96	-	-	17.46	-	-	25.89
G.C.A.	5	5	128.09**	211.26**	328.02**	26.76*	134.80**	123.49**	18.95	225.48**	160.94**
S.C.A.	15	15	56.88**	17.63**	56.30**	18.23	17.12**	9.95	22.43	40.16**	35.22
G.C.A. x I	-	5	-	-	11.33**	-	-	38.07**	-	-	83.44**
S.C.A. x I	-	15	-	-	18.21**	-	-	4.6	-	-	50.85**
Error	60	120	2.417	3.239	2.828	10.762	4.281	7.521	17.90	21.01	19.453
GCA/SCA	-	-	0.288	1.82	0.76	0.268	1.27	5.97	0.09	1.33	1.127
Total	83	167									

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

Table 1. Continued.

S.O.V.	d.f.		No. of kernel/spike			100 kernel weight			Grain yield/plan (gm)		
	Separate	Comb.	N	S	Comb.	N	S	Comb.	N	S	Comb.
Replicattion	3	-	0.808	2.81	-	0.208	0.151	-	7.40	3.84	-
Irrigations(I)	-	1	-	-	446.56**	-	-	5.70**	-	-	573.65**
Rep. with irrig. (E_1)	-	6	-	-	12.80	-	-	0.179	-	-	5.62
Genotypes(g)	20	20	19.30*	49.74**	43.72**	0.304**	0.351**	0.576**	8.93	31.14**	27.18**
Parents(p)	5	5	20.91*	34.28**	42.75	0.803**	0.53**	1.200**	5.46	67.05**	46.46
Crosses©	14	14	19.68**	58.82**	46.94**	0.120	0.24*	0.296**	10.43	20.13**	21.45*
Pvs c	1	1	5.93	0.08	3.49	0.39	1.01	1.38	5.28	5.73	11.00
Par. x Irrig.	-	20	-	-	25.33**	-	-	0.079**	-	-	12.89**
Crosses x Irrig.	-	5	-	-	12.44*	-	-	0.133	-	-	26.05**
Pvs.C x Irrig.	-	14	-	-	31.56**	-	-	0.064	-	-	9.11**
G.C.A.	-	1	-	-	2.56	-	-	0.019	-	-	0.01
S.C.A.	5	5	21.84**	113.32**	84.60**	0.364**	0.290**	0.571**	10.31	81.40**	56.45**
G.C.A. x I	15	15	18.46**	28.55**	30.09**	0.284**	0.371**	0.577**	8.46	14.39**	17.42**
S.C.A. xI.	-	5	-	-	50.56**	-	-	0.083	-	-	35.26**
Error	-	15	-	-	16.92**	-	-	0.078	-	-	5.43
	60	120	5.610	4.717	5.164	0.099	0.081	0.090	5.119	3.257	4.19
GCA/SCA	-	-	0.158	0.569	0.398	0.179	0.204	0.123	0.194	0.877	0.443
Total	83	167									

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

Mean squares due to combining ability (general (G.C.A) and specific (S.C.A) combining abilities) for the studied traits in each environment and their combined as well as the interactions between environment and each of general and specific combining ability were highly significant with some exceptions, indicating the presence of both additive and non-additive types of gene effects in the genetic system controlling these traits. Mean squares due to of GCA were higher than those of SCA for all the studied traits under both irrigation treatments. These results suggest a predominant role of additive type of gene action for these traits. Similar results were obtained by Hamada *et al.* (2002), Darwish (2003), EL-Borhamy (2004) and Abd El-Aty and Hamad (2006).

GCA/SCA ratios of less than unity were detected for all studied traits except days to heading, days to maturity and plant height under stress conditions, indicating the predominance of non-additive gene action in the inheritance of most studied traits (Table 1).

Mean performance

The mean performance of the six genotypes and their F_1 crosses under normal and stress conditions as well as combined data are presented in Table (2).

The mean performance for all genotypes were generally, decreased due to stress conditions and deficiency of soil moisture.

Regarding heading and maturity dates, Sakha 93 was the earliest variety while Gemmeiza 9 was the latest under both conditions. The earliest crosses were obtained under both conditions from Sakha 93 x Giza 168 and Sakha 93 x Dobary.

These results revealed that the variety Sakha 93 possessed genes controlling earliness for heading and maturity, while Gemmeiza 9 has genes for lateness. Similar results were obtained by Mohammed (2001), Moursi (2003) and El-Dansory (2005).

With respect to plant height, the tallest parents were Giza 168 and Sids 1 under normal conditions and for combined data, while Giza 168 and Onomly were the tallest under stress conditions.

The tallest crosses were; Sakha 93 x Onomly, Giza 168 x Sids 1 and Dobary x Onomly under normal conditions, while Giza 168 x Onomly, Dobary x Onomly and Onomly x Sids 1, as well as Giza 168 x Onomly, Giza 168 x Sids 1, Dobary x Onomly and Onomly x Sids 1 were the tallest under stress and for combined analysis. These results indicated that there were differences among genotypes in plant height under the two irrigation treatments. The reduction in plant height due to water stress may be attributed to the reduction in internode length, because of the deficiency of soil moisture. Similar results were obtained by Moursi (2003), Mohamed (2004) and El-Dansory (2005).

Table 2. Mean performance of parents and their F_1 crosses for all studied traits under each irrigation regime and across the two regimes.

Genotypes		Heading date (days)			Maturity date (days)			Plant height (cm)		
		N	S	Comb.	N	S	Comb.	N	S	Comb.
Sakha 93	(P_1)	94.30	89.00	91.60	152.0	141.50	146.8	115.5	100.8	108.1
Giza 168	(P_2)	101.0	92.20	96.50	154.0	145.50	149.8	118.8	113.8	116.3
Dobary	(P_3)	108.5	96.80	98.60	155.8	141.30	148.5	117.5	105.3	111.4
Omnaly	(P_4)	108.3	102.00	105.10	155.0	147.8	151.4	116.3	114.8	115.5
Sids 1	(P_5)	102.30	101.3	101.8	153.0	152.0	152.5	120.0	112.5	116.3
Gemmeiza 9	(P_6)	110.8	102.30	106.5	157.8	152.8	155.3	117.5	105.8	111.6
Sakha 93 x Giza 168		99.5	91.50	95.5	151.8	143.8	147.8	115.3	107.0	111.1
Sakha 93 x Dobary		99.0	92.50	95.8	153.5	144.0	148.8	115.0	106.5	110.8
Sakha 93 x Omnaly		100.8	93.00	96.9	154.3	144.5	149.4	121.3	113.5	117.4
Sakha 93 x Sids 1		103.3	99.00	104.1	154.8	141.5	148.1	118.8	112.0	115.4
Sakha 93 x Gemmeiza 9		97.8	92.80	95.3	153.8	144.3	149.1	120.0	108.5	114.3
Giza 168 x Dobary		101.5	93.30	97.4	158.3	142.8	150.5	117.3	113.8	115.5
Giza 168 x Omnaly.		101.8	95.50	98.6	155.5	143.0	149.3	118.5	117.5	118.0
Giza 168 x Sids 1		103.5	99.80	104.6	159.5	146.8	153.1	115.5	123.8	119.6
Giza 168 x Gemmeiza 9		102.8	100.80	101.8	153.8	147.8	150.8	116.3	111.0	113.6
Dobary .x Omnaly		97.8	96.50	97.1	152.5	145.0	148.8	120.0	116.3	118.1
Dobary x Sids 1		104.3	98.30	101.3	154.0	149.3	151.6	117.5	112.3	114.9
Dobary. x Gemmeiza 9		106.8	99.30	103.0	157.8	148.5	153.1	118.0	112.8	115.4
Omnaly .x Sids 1		104.5	98.30	101.4	154.5	148.0	151.3	118.8	117.3	118.0
Omnaly. x Gemmeiza 9		103.0	96.50	99.8	153.3	150.8	152.0	119.5	108.8	114.1
Sids 1 x Gemmeiza 9		105.3	102.80	104.0	158.8	147.8	153.3	117.5	114.0	115.8
L.S.D.	0.05	2.180	2.532	2.366	4.616	2.911	3.859	7.130	5.118	6.206
	0.01	2.900	3.368	3.139	6.124	3.862	5.127	9.459	6.790	8.233

N : Normal S:Stress

Table 2. Cont.

Genotypes		No. of kernels/spike			100 kernel weight			Grain yield/plant (gm)		
		N	S	Comb.	N	S	Comb.	N	S	Comb.
Sakha 93	(P_1)	65.25	60.70	62.97	5.68	5.38	5.53	39.36	28.81	34.08
Giza 168	(P_2)	67.50	66.00	66.75	5.42	4.99	5.20	42.38	39.30	40.84
Dobary	(P_3)	65.10	58.35	61.72	5.78	5.05	5.42	40.29	36.65	38.47
Omnaly	(P_4)	64.0	63.90	63.95	5.71	5.12	5.41	41.45	38.50	39.98
Sids 1	(P_5)	69.57	65.22	67.40	4.73	4.72	4.72	39.75	37.50	38.63
Gemmeiza 9	(P_6)	68.88	64.00	66.44	4.92	4.33	4.62	40.50	39.31	39.91
Sakha 93	x Giza 168	67.40	65.05	66.22	5.27	4.88	5.07	43.93	40.08	42.00
Sakha 93	x Dobary	65.20	55.85	60.53	5.48	5.01	5.25	38.35	31.80	35.08
Sakha 93	x Omnaly	67.15	65.70	66.43	5.64	5.65	5.64	41.16	34.48	37.82
Sakha 93	x Sids 1	6.40	63.80	65.10	5.62	5.25	5.43	41.21	37.16	39.18
Sakha 93	x Gemmeiza 9	66.68	62.50	64.59	5.52	5.14	5.33	42.64	35.36	38.99
Giza 168	x Dobary	67.30	61.35	64.32	5.69	5.53	5.61	40.15	37.64	38.90
Giza 168	x Omnaly.	62.15	62.15	62.15	5.78	5.39	5.55	39.43	36.15	37.79
Giza 168	x Sids 1	65.80	63.85	64.82	5.77	5.27	5.52	40.82	37.71	39.20
Giza 168	x Gemmeiza 9	69.75	67.00	68.38	5.49	5.25	5.37	43.13	40.17	41.65
Dobary.	x Omnaly	65.35	64.04	64.70	5.45	4.74	5.09	40.53	38.22	39.38
Dobary.	x Sids 1	61.45	61.25	61.30	5.20	5.09	5.14	40.35	37.25	38.80
Dobary.	x Gemmeiza 9	66.78	55.90	61.34	5.64	5.27	5.46	41.18	39.09	40.13
Omnaly.	x Sids 1	69.30	68.25	68.78	5.30	4.98	5.14	38.65	39.0	39.07
Omnaly.	x Gemmeiza 9	66.57	62.45	64.51	5.39	4.98	5.19	43.04	37.23	40.13
Sids 1	x Gemmeiza 9	69.87	61.25	65.15	5.68	5.25	5.46	41.33	38.75	40.04
L.S.D.	0.05	3.332	4.322	3.198	0.443	0.39	0.422	1.992	2.539	2.879
	0.01	4.421	5.734	4.242	0.588	0.529	0.560	2.643	3.368	3.820

egarding 100 kernel weight, the heaviest parents were Sakha 93, Giza 168, Dobary and Onomly under all conditions.

On the other hand, the heaviest 100 kernel weight for crosses under all conditions was shown by Sakha 93 x Onomly, Giza 168 x Dobary, Giza 168 x Onomly and Giza 168 x Sids 1.The decrease in grain weight due to drought conditions could be attributed to reduced grain filling period and/or reduction in photosynthesis and translocation of reserves to grains (Keim and Kronstad, 1981). The results agreed with those obtained by Moursi (2003) and El-Dansory (2005). With respect to number of kernels/spike, parents Giza 168, Sids 1 and Gemmeiza 9 had higher number of kernels/spike under all conditions, while the crosses Giza 168 x Gemmeiza 9 and Onomly x Sids 1 were the best crosses.

Decreased mean number of kernels/spike may be due to effect of water deficiency on pollination and fertilization processes. Similar results were obtained by Weber and Hrysnozuk (1999), Mohammed (2001), Moursi (2003) and El-Dansory (2005).

Regarding grain yield/plant (g), Giza 168 was the highest yielder (42.38 and 40.84 g) followed by Onomly (41.45 and 39.98 g) under normal and combined conditions, while Gemmeiza 9 gave (39.81 g) followed by Giza 168 (39.30) were the best under stress conditions.

With respect to crosses, Sakha 93 x Giza 168 and Giza 168 x Gemmeiza 9 were the highest yielding crosses under both irrigation conditions. Moreover, crosses Sakha 93 x Gemmeiza 9 and Onomly x Gemmeiza 9 under normal conditions, Dobary x Gemmeiza 9, and Onomly x sids 1 under stress conditions were the best crosses, for grain yield. Similar results were obtained by Darwish (2003) and El-Dansory (2005).

Kheiralla (1994), Darwish (1998) and El-Dansory (2005) reported highly significant differences among genotypes under water stress treatments for grain yield of bread wheat.

Combining ability

General combining ability effects

The general combining ability effects are given in Table (3). Since negative value of GCA effect would be of interest for earliness, the varieties Sakha 93 and Dobary under normal irrigation for days to heading, and Sakha 93 under both conditions as well as Giza 168 and Dobary under stress conditions for days to maturity which could be considered the best general combiners,i.e for improving earliness, by their hybrids under the previous conditions.

Highly significant positive GCA effects for plant height were detected in Onomly and Sids 1 and Giza 168 under water stress conditions, showing that these genotypes are suitable to breeding programs for tallness under stress conditions.

Table 3. Estimates of general combining ability effects of all parents for all studied traits in each environment.

Characters / parents	Days to heading			Days maturity			Plant height		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sakha 93	-3.128**	3.927**	-3.526**	-1.552**	-2.719**	-2.135**	-0.604	-4.031**	-2.318**
Giza 168	-0.344	1.490**	-0.917**	0.292	-0.969**	-0.339	-0.260	1.938**	0.839
Dobary	-1.188**	0.615*	-0.901**	0.385	-1.344**	-0.479	0.854	-0.719	-0.786
Onomly	0.563*	0.698*	0.630*	-0.552	0.500	-0.26	0.427	2.813**	1.620**
Sids 1	1.938**	3.042**	2.490**	0.385	1.813**	1.09**	1.271	1.844**	1.557**
Gemmeiza 9	2.156**	2.292**	2.224**	1.042*	2.719**	1.880**	0.021	1.844**	-0.911
L.S.D. gi 0.05	0.499	0.578	0.496	1.033	0.664	0.737	1.627	1.168	1.079
0.01	0.662	0.767	0.658	1.397	0.882	0.978	2.158	1.549	1.432
L.S.D. gi-gj 0.05	0.773	0.896	0.769	1.632	1.029	1.141	2.520	1.809	1.671
0.01	1.026	1.187	1.020	2.166	1.365	1.514	3.344	2.401	2.218

Characters / parents	No. of kernels/spike			1000 kernels weight (g			Grain yield/plant		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sakha 93	-0.078	-0.883*	-0.466	0.067	0.117*	0.093**	-0.039	-2.966**	-1.517**
Giza 168	-0.156	1.872**	0.858**	0.049	0.068	0.089	0.737*	1.238**	0.988**
Dobary	-0.969*	-3.253**	-2.106**	0.048	-0.03	0.041	-0.648	-0.392	-0.519
Onomly	-0.703	1.84**	0.241	0.068	0.028	0.048	0-0.078	0.267	0.096
Sids 1	0.689	1.209**	0.934**	-0.167**	-0.060	-0.114**	-0.557	0.618*	0.029
Gemmeiza 9	1.238**	-0.159	0.539	-0.101*	-0.150**	-0.126**	0.578	1.269**	0.923**
L.S.D. gi 0.05	0.761	0.697	0.644	0.101	0.091	0.069	0.723	0.579	0.529
0.01	1.019	0.925	0.854	0.136	0.121	0.091	0.963	0.768	0.702
L.S.D. gi-gj 0.05	1.178	1.080	0.997	0.157	0.141	0.105	1.126	0.897	0.819
0.01	1.563	1.433	1.324	0.208	0.187	0.139	1.493	1.191	1.087

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

The varieties Giza 168, Onomaly and Sids 1 showed highly significant positive GCA effects for number of kernels/spike under stress conditions, while Gemmeiza 9 was the best combiner for kernels/spike under non-stress conditions.

The variety Sakha 93 expressed significant or highly significant positive G.C.A effects for 100 kernels weight under stress conditions.

With respect to grain yield/plant, significant or highly significant positive GCA effects were detected by Giza 168 under both stress and non-stress and by Gemmeiza 9 under stress conditions, indicating that they possess favorable genes for yield and that improvement in yield can be attained by their use in breeding programs.

Specific combining ability effects

Table (4) presents the estimates of SCA effects for the studied characters in the crosses under normal and stress conditions.

Results indicated that, the best combinations under both conditions for days to heading were Sakha 93 x Gemmeiza 9 and Onomly x Gemmeiza 9 which exhibited the lowest SCA effects for earliness. On the other hand, the best crosses for earliness in maturity under the stress conditions were Sakha 93 x Sids 1, Giza 168 x Onomly, Sids 1 x Gemmeiza 9 and Sakha 93 x Gemmeiza 9.

Table 4. Estimates of specific combining ability effects for F_1 crosses for all studied traits in each environment and their combined data.

Crosses	Heading date (day)			Maturity date (day)			Plant height (cm)		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sakha 93 x Giza 168	0.147	0.036	0.092	-1.906	1.330	-0.288	-1.897	-2.513	-2.205
Sakha 93 x Dobary	0.491	0.161	0.326	-0.250	1.955*	0.8523	-1.554	-0.357	-0.955
Sakha 93 x Onomly	0.491	-0.652	-0.080	1.438	0.612	1..025	3.415	3.112	3.263*
Sakha 93 x Sids 1	7.616**	3.004**	5.310**	1.000	-3.701**	-1.350	0.071	2.580	1.326
Sakha 93 x Gemmeiza.9	-4.103**	-2.496**	-3.299**	-0.656	-1.857*	-1.257	2.571	2.768	2.670
Giza 168 x Dobary	0.210.	-1.527*	-0.658	2.656	-1.045	0.806	-3.147	4.424**	0.638
Giza 168 x Onomly.	-1.290	-0.589	-0.940	0.844	-2.638**	-0.897	-0.679	2.143	0.732
Giza 168 x Sids 1	5.885**	1.317*	3.201**	3.906**	-0.201	1.853	4.728*	0.112	2.420
Giza 168 x Gemmeiza.9	-1.884**	3.067**	0.592	-2.500	-0.107	-1.304	-1.522	-0.701	-1.112
Dobary. x Onomly	-4.446**	-0.464	-2.455**	-2.250	-0.263	-1.257	2.415	2.549	2.482
Dobary. x Sids 1	0.679	-1.058	-0.190	-1.688	2.674**	0.493	-0.929	-0.482	-0.705
Dobary. x Gemmeiza.9	2.960	0.692	1.826**	1.406	1.018	1.212	0.821	3.705*	2.2663
Onomly. x Sids 1	-0.821	-2.371**	-1.596*	0.250	-0.420	-0.335	-0.960	0.987	0.013
Onomly x Gemmeiza.9	-2.540**	-3.371*	-2.955**	-2.156	1.424	-0.366	1.0410	-3.826*	-1.393
Sids 1 x Gemmeiza.9	-1.665*	0.536	-0.565	2.406	-2.888**	-0.241	-1.804	2.393	0.295
L.S.D.sij 0.05	1.371	1.311	1.363	2.893	1.825	2.023	3.690	3.208	2.964
0.01	1.818	1.738	1.809	3.838	2.421	2.684	4.896	4.256	3.932
L.S.D.sij-skl 0.05	1.894	2.193	2.034	3.997	2.521	3.019	6.174	4.433	4.424
0.01	2.513	2.909	2.699	5.303	3.344	4.006	8.191	6.59	5.869
L.S.D. sij-sik 0.05	2.046	3.369	2.035	4.318	2.733	3.019	6.669	4.787	4.424
0.01	2.715	3.143	2.699	5.728	3.613	4.006	8.847	6.351	5.869

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

Table 4. Cont..

Crosses		No. of kernel/spike			100 kernel weight (g)			Grain yield/plant (g)		
		Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sakha 93 x Giza 168		1.356	1.013	1.185	-0.325*	-0.418**	-0.372**	2.326*	4.628**	3.477**
Sakha 93 x Dobary		-0.041	-3.862**	-1.551	-0.148	-0.212	-0.180	-1.867	-20.17*	-1.942**
Sakha 93 x Onomly		1.653	2.351*	2.002*	0.023	0.397**	0.210*	0.376	-0.001	0.187
Sakha 93 x Sids 1		-0.460	0.426	-0.017	0.239	0.085	0.161	0.900	2.331**	1.615*
Sakha 93 x Gemmeiza 9		-0.763	0.495	-0.134	0.073	0.0698	0.070	1.195	-0.123	0.536
Giza 168 x Dobary		2.137*	-0.287	0.925	0.076	0.357**	0.216*	-0.843	-0.411	-0.627
Giza 168 x Onomly		-3.269**	-3.924**	-3.597**	0.102	0.189	0.145	-2.138*	-2.560**	-2.349**
Giza 168 x Sids 1		-2.932**	-0.296	-1.615	0.405**	0.164	0.284**	-0.267	1.353	-0.810
Giza 168 x Gemmeiza 9		-0.360	5.20**	2.330*	0.061	0.222	0.141	0.913	0.456	0.685
Dobary. x Onomly		0.734	3.101**	1.917*	-0.179	-0.397**	-0.288**	0.354	1.143	0.748
Dobary. x Sids 1		-4.529	0.276	-2.126*	-0.196	0.043	-0.076	0.656	-0.178	0.239
Dobary. x Gemmeiza 9		0.218	-3.705**	-1.744	0.181	0.313*	0.247*	0.341	1.004	0.672
Onomly. x Sids 1		3.065**	2.839**	2.952**	-0.080	-0.093	-0.086	-1.622	1.408	-0.107
Onomly. x Gemmeiza 9		-0.238	-1.593	-0.915	-0.056	-0.085	-0.031	1.633	-1.513	0.060
Sids 1 x Gemmeiza 9		0.980	-2.818**	-0.959	0.465**	0.352**	0.409**	0.408	-0.339	0.034
L.S.D.sij	0.05	2.002	1.915	1.769	0.278	0.250	0.186	1.9695	1.592	1.453
	0.01	2.771	2.54	2.347	0.368	0.332	0.246	2.647	2.111	1.928
L.S.D.sij-sld	0.05	2.886	2647	2.639	0.384	0.346	0.276	2.757	2.199	2.168
	0.01	3.829	3.511	3.502	0.509	0.459	0.367	3.657	2.917	2.877
L.S.D Sij-Sik	0.05	3.118	2.859	2.640	0.415	0.374	0.276	2.978	2.375	2.169
	0.01	4.136	3.792	3.502	0.549	0.496	0.367	3.951	3.151	2.877

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

Significant or highly significant and positive effects for plant height were detected by cross Giza 168 x Sids 1 under normal conditions and Giza 168 x Dobary and Dobary x Gemmeiza 9 under stress conditions.

For number of kernels/spike, the crosses Sakha 93 x Onomly, Giza 168 x Gemmeiza 9, Dobary x Onomly and Onomly x Sids 1 under water stress conditions, and Onomly x Sids 1 and Giza 168 x Dobary under normal conditions are considered the promising hybrids for improving number of kernels/spike, as they showed significant or highly significant positive SCA effects.

With respect to 100 kernels weight, highly significant positive SCA effects were obtained from crosses Sakha 93 x Onomly, Giza 168 x Dobary and Dobary x Gemmeiza 9 and Sids 1 x Gemmeiza 9 under stress conditions and Giza 168 x Sids 1 and Sids 1 x Gemmeiza 9 under normal conditions. For grain yield/plant the cross Sakha 93 x Giza 168 under both conditions and cross Sakha 93 x Sids 1 under stress conditions exhibited positive and significant or highly significant SCA effects. Similar results were obtained by Afiah and Darwish (2002), Hamada *et al.* (2002), Darwish (2003) and El-Dansory (2005).

Drought susceptibility index (DSI)

Mean squares due to genotypes, general and specific combining ability for drought susceptibility index (DSI) expressed by all studied traits were highly significant except those for 100 kernels/weight. (Table 5) Such results indicated a wide diversity between the genotypes used in this study in DSI expressed by different studied traits.

Table 5. Mean squares form analysis of variance, and general and specific combining ability analysis of susceptibility index for all studied traits.

S.O.V	d.f	Days to heading	Days to maturity	Plant height (cm)	N of kernel /spike	100 kernels weight(g)	Grain yield/plant (g)
Replications	3	0.233	0.069	0.751	2.848	3.053	0.235
Genotypes	20	0.874**	0.714**	2.056**	4.763**	0.094	1.982**
Parents(p)	5	1.327**	1.120**	2.66	2.423	1.741	4.230**
Crosses(c)	14	0.735**	0.590**	1.64	5.903**	0.863	1.321**
P.vs.C.	1	0.57	0.42	4.86*	0.503	1.093	0.004
G.C.A.	5	0.784**	1.019**	4.313**	9.775**	1.23	5.393*
S.C.A.	15	0.904**	0.613**	1.303*	30.09**	1.084	0.845*
Error	60	0.177	0.200	1.122	1.116	1.528	0.594

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

A drought susceptibility index (DSI) which provides a measure of stress resistance based on minimization of yield loss under stress as compared to optimum conditions, rather than on yield level under stress, has been used to characterize the relative drought tolerance of wheat genotypes (Fisher and Maurer 1978). reported that genotypes identified as stress tolerance using stress susceptibility index should possess tolerance mechanisms which may need to be incorporated into germplasm with higher yield potential for development of high yielding and stress tolerant cultivars. This index was used to estimate the relative stress injury because it accounted for variation in yield potential and stress intensity. This index could be estimated based on many traits. Lower stress susceptibility index then unity (SI < 1)is a synonymous to high stress tolerance, while higher stress susceptibility index than unity (SI > 1) means high stress sensitivity.

The mean performance for (DSI) of all genotypes calculated for all studied traits is presented in Table (6).

Data indicated that the parents Sakha 93, Dobary, Onomly and Sids 1, the crosses Sakha 93 x Gemmeiza 9, Giza 168 x Gemmeiza 9, Dobary x Onomly, Dobary x Sids 1 and Sids 1 x Gemmeiza 9 showed resistance to the stress irrigation conditions for days to heading, the best parent was Sids 1, while the best cross Dobary x Onomly. For maturity date all parents possessed (DSI) lower than one, except Sakha 93 and Dobary, revealing that these two parents were susceptible expressed by days to maturity, while the crosses Dobary x Sids 1 and Onomly x Gemmeiza 9 showed the highest tolerance for this trait.

Regarding (DSI) for plant height parents Giza 168, and Onomly and crosses Giza 168 x Dobary and Giza 168 x Onomly showed the highest resistance to stress conditions

Two parental varieties (Giza 168, Onomly) and nine crosses showed the highest tolerance to stress environments expressed by number of kernels/spike.

Table 6. Drought susceptibility index (DSI) of all studied traits for all genotypes.

Genotypes		Days to heading	Days to maturity	Plant height (cm)	N. of kernels/ spike	100 kernels weight (g)	Grain yield./ plant (g)
Sakha 93	(P_1)	0.96	1.22	2.33	1.42	0.78	2.97
Giza 68	(P_2)	1.41	0.97	0.70	0.44	1.14	0.80
Dobary	(P_3)	0.64	1.64	1.91	2.09	1.86	0.91
Onomly	(P_4)	0.99	0.82	0.19	-0.08	1.52	0.77
Sids 1	(P_5)	-0.17	0.11	1.15	1.23	0.01	0.63
Gemmeiza 9	(P_6)	1.32	0.54	1.83	1.43	1.47	-0.08
Sakha 93	x Giza 168	1.39	0.93	1.30	0.60	0.95	0.87
Sakha 93	x Dobary	1.13	1.08	1.34	2.90	1.24	1.89
Sakha 93	x Onomly	1.33	1.11	1.17	0.43	-0.10	1.80
Sakha 93	x Sids 1	1.62	1.50	0.99	0.79	0.95	1.07
Sakha 93	x Gemm.9	0.88	1.06	1.73	1.25	0.97	1.83
Giza 168	x Dobary	1.40	1.72	-0.58	1.75	0.37	0.66
Giza 168	x Onomly	1.05	1.41	-0.18	-0.01	0.78	0.92
Giza 168	x Sids 1	1.54	1.39	1.16	-0.69	1.23	0.83
Giza 168	x Gemm.9	0.33	0.67	0.80	-0.54	0.60	0.75
Dobary.	x Onomly	0.22	0.86	0.54	0.39	1.90	0.58
Dobary.	x Sids 1	0.99	0.53	0.80	0.05	0.31	0.58
Dobary.	x Gemm.9	1.21	1.03	0.81	3.29	.97	0.54
Onomly.	x Sids 1	1.03	0.74	0.22	0.31	0.86	-0.25
Onomly.	x Gemm.9	1.09	0.28	1.62	1.26	1.05	1.47
Sids 1	x Gemm.9	0.41	1.21	0.50	2.30	1.10	0.68
L.S.D.	0.05	0.583	0.620	1.46	2.121	1.713	1.068
	0.01	0.767	0.816	1.93	2.721	2.604	1.406

Two parents (Sakha 93 and Sids 1)and ten crosses had desirable DSI values for 100 kernel weight. The best parent was Sids 1 while the best cross was Sakha 93 x Onomly in DSI values for 100 kernel weight.

Regarding grain yield/plant all parents except parent Sakha 93 and eleven crosses showed low susceptibility (SI < 1) to stress conditions.

The parents Sids 1, Onomly and Giza 168 and crosses Giza 168 x Gemmeiza 9, Onomly x Sids 1, Dobary x Sids 1, and Dobary x Onomly, had the highest tolerance to stress environment (DSI) for most studied traits.

In general, it could be concluded that; selecting genotypes that are superior to the average yield and its attributes under different environments (normal, stress) include the genotypes, successfully and adapted to be grown in the environmental stress conditions and could be used in wheat breeding programs for stress conditions.

Estimates of general combining ability effects of DSI expressed by all studied traits are presented in Table (7).The genotypes which have highly significant negative GCA effect for drought susceptibility indices for the desirable traits are of interest for breeding programs.

Highly significant negative GCA effect of DSI for days to heading was found in Sids 1. Moreover, the parental genotypes Sids 1 and Gemmeiza 9 gave significant negative GCA effects for drought susceptibility index in days to maturity.

Table 7. Estimates of general combining ability effects (gi) of drought susceptibility index for all studied traits.

Parents		Days to heading	Days to maturity	Plant height (cm)	N of kernel /spike	100 kernels weight(g)	Grain yield /plant(g)
Sakha 93		0.167*	0.145*	-0.553**	0.256	-0.137	0.819**
Giza 168		0.202**	0.140	-0.359*	-0.635**	-0.055	-0.151
Dobary		-0.085	0.195**	-0.006	0.723*	0.231	-0.059
Onomly		-0.028	-0.112	-0.378*	-0.567**	0.112	-0.094
Sids 1		-0.209**	-0.168*	-0.102	0.195	-0.271	-0.300*
Gemmeiza 9		-0.046	-0.199**	0.292	0.419*	0.121	-0.215
L.S.D. gi	0.05	0.135	0.144	0.340	0.339	0.397	0.248
	0.01	0.179	0.190	0.451	0.450	0.527	0.329
L.S.D. gj-gj	0.05	0.210	0.222	0.527	0.525	0.165	0.383
	0.01	0.278	0.295	0.699	0.697	0.815	0.508

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

The parental genotypes Giza 168 and Onomly showed significantly negative GCA effect of DSI for plant height and number of kernels/spike.

The parent Sids 1 showed negative and significant GCA effect of DSI for grain yield/plant.

The parent Sids 1 could be considered as good combiner for D S I expressed by both earliness and grain yield/plant.

Estimates of specific combining ability effects of the crosses for drought susceptibility index are presented in Table (8). The cross combinations Giza 168 x Gemmeiza 9 and Dobary x Onomly were the best crosses for days to heading for drought susceptibility index, while for maturity date were crosses Dobary x Sids 1 and Onomly x Gemmeiza 9 were the best in S C A effects.

For plant height cross Giza 168 x Dobary expressed significant negative S C A effects for DSI. For number of kernels/spike, crosses Giza 168 x Gemmeiza 9 and Dobary x Sids 1 were the best concerning S C A effects for drought susceptibility index. With respect to grain yield/plant, the crosses Sakha 93 x Giza 168 and Onomly x Sids 1 showed significant negative SCA effects for DSI.

In this respect Saadalla (1994), Esmail and El-Tabakh (1995), Abul-Naas *et al.* (2000),EL-Borhamy (2000), Darwish (2003) and El-Dansory (2005) evaluated some bread wheat genotypes for drought resistance under different water regimes and reported that the entries exhibited a wide range of response to drought using stress susceptibility index based on grain yield and some of its components.

Table 8. Estimates of specific combining ability effects (sij) for drought susceptibility index expressed by all studied traits.

Crosses		Days to heading	Days to maturity	Plant height (cm)	N. of kernels spike	100 kernels weight (g)	Grain yield., plant (g)
Sakha 93	x Giza 168	0.029	-0.352	0.141	0.014	0.190	-0.778*
Sakha 93	x Dobary.	0.056	-0.250	-0.173	0.9549	0.191	0.150
Sakha 93	x Onomly.	0.201	0.085	0.209	-0.221	-1.022	0.100
Sakha 93	x Sids 1	0.677**	0.528**	-0.435	-0.243	0.410	-0.430
Sakha 93	x Gemm.9	-0.231	0.122	-0.083	-0.390	0.0034	0.246
Giza 168	x Dobary.	0.299	0.395*	-1.180*	0.695	-0.761	-0.099
Giza 168	x Onomly.	-0.109	0.390	-0.408	0.220	-0.226	0.190
Giza 168	x Sids 1	0.557**	0.431*	0.653	-0.830	0.611	0.301
Giza 168	x Gemm.9	-0.814**	-0.257	-0.103	-1.589*	-0.420	0.136
Dobary.	x Onomly.	-0.656**	-0.208	-0.048	-0.733	0.448	-0.239
Dobary.	x Sids 1	0.299	-0.485*	-0.055	-1.446**	0.602	0.242
Dobary.	x Gemm.9	0.351	0.042	-0.443	1.172*	-0598	-0.161
Onomly.	x Sids 1	0.280	0.028	-0.263	0.105	-0.331	-0.831*
Onomly.	x Gemm.9	0.17	-0.395*	0.738	0.445	0.071	0.809*
Sids 1	x Gemm.9	-0.330	0.590**	-0.661	1.100*	-0.127	0.215
L.S.D. sij	0.05	0.371	0.395	0.934	0.932	1.089	0.679
	0.01	0.492	0.523	1.239	1.236	1.445	0.901
L.S.D. sij-ski	0.05	0.512	0.545	1.290	1.287	1.506	0.939
	0.01	0.680	0.723	1.712	1.708	1.998	1.246
L.S.D. sij-sik	0.05	0.554	0.589	1.394	1.390	1.626	1.015
	0.01	0.734	0.781	1.850	1.845	2.158	1.346

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

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تقديرات القدرة على التآلف ومعامل الحساسية للجفاف فى الهجن التبادلية لقمح الخبز تحت معاملتى الرى الطبيعى والإجهاد المائى

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أجرى هذا البحث بالمزرعة التجريبية بكلية الزراعة بجامعة كفرالشيخ خلال الموسمين 2005/2004م ، 2006/2005م لدراسة القدرة على الآتلاف ودليل الحساسية للإجهاد المائى فى ستة أصناف لربعة محلية وهى: سخا 93 ، جيزه 168 ، سدس 1 ، جميزه 9 وصنفان مستوردان هما أونوملى ودوبرى وتم فى الموسم الأول 2005/2004م التهجين فيما بينها بطريقة التهجين الدائرى وفى الموسم الثانى 2006/2005م تم زراعة الأباء والهجن الناتجة منها فى تجربتين منفصلتين ، التجربة الأولى رويت ثلاثة ريات بالإضافة إلى رية الزراعة (رى طبيعى) والتجربة الثانية رويت رية واحدة بالإضافة إلى رية الزراعة (إجهاد مائى) ، وزرعت كل تجربة فى نظام

القطاعات الكاملة العشوائية فى أربعة مكررات حيث تمت الدراسة على الصفات التالية: عدد الأيام حتى طرد السنابل ، عدد الأيام حتى النضج ، ارتفاع النبات ، عدد حبوب السنبلة ، وزن المائة حبة ، محصول النبات الفردى ، ودليل الحساسية للجفاف لجميع الصفات المختلفة. وقد تم تحليل البيانات طبقا لجريفنج الطريقة الثانية النموذج الأول عام 1956م ، كما تم تقدير معامل الحساسية للجفاف لجميع الصفات.

ويمكن تلخيص أهم النتائج فى ما يلى:

1-أدى الإجهاد الرطوبى إلى نقص متوسطات التراكيب الوراثية (الأباء والهجن) لجميع الصفات المدروسة بالإضافة إلى الإسراع فى طرد السنابل والنضج الفسيولوجى.

2-أظهرت النتائج وجود تأثير عالى المعنوية لمعاملتى الرى على جميع الصفات مما يوضح اختلاف تأثير المعاملتين على هذه الصفات وكانت الاختلافات بين التراكيب الوراثية ، وتفاعل التراكيب الوراثية مع معاملتى الرى معنويا لجميع الصفات المدروسة.

3-كانت أحسن الأباء للقدرة العامة على الإئتلاف لمحصول الحبوب للنبات وواحدة أو أكثر من الصفات المساهمة فيه هو الصنف جيزه 168 ، فى حين يعتبر الصنف سخا 93 أحسن الأصناف فى أنتاج هجن مبكرة تحت كل الظروف.

4-أفضل الهجن للقدرة الخاصة على الإئتلاف للتبكير هو الهجين سخا 93 × جميزه 9 ولصفة عدد حبوب السنبلة الهجين أونملى × سدس 1 ، ولوزن المائة حبة الهجين سدس 1 × جميزه 9 ، ولمحصول الحبوب للنبات الهجين سخا 93 × جيزه 168 وذلك تحت كل الظروف.

5-أوضح التحليل الوراثى لبيانات دليل الحساسية للجفاف (الإجهاد المائى) أن الأب سدس1 كان أفضل الأصناف بالنسبه لعدد الأيام حتى النضج فى حين كان أفضل هجين هو أونملى × جميزه 9 ، وكان أفضل الأصناف لمحصول حبوب النبات هو جميزه 9 ، وأفضل هجين لهذه الصفة هو أونملى × سدس 1 حيث أعطت أقل قيم لمعامل الإجهاد المائى حيث كانت أكثر تحملا لنقص الماء.

6-كان التباين الراجع للتراكيب الوراثية والقدرة على الإئتلاف (عامة وخاصة) معنويا لكل الصفات المدروسة لمعامل الحساسية للجفاف فيما عدا صفة وزن المائة حبة.

7-أعطى الصنف سدس 1 قدرة إئتلافية معنوية وسالبة لمعامل الحساسية للجفاف لمحصول الحبوب للنبات والتبكير ، فى حين أعطى الصنف جيزه 168 قدرة إئتلافية مرغوبة بالنسبه لمعامل الحساسية للجفاف لصفتى ارتفاع النبات وعدد حبوب السنبلة.

8-أظهرت الهجن (جيزه 168 × جميزه 9) ، (دوبرى × أونملى) ، (دوبرى × سدس 1) ، (أونملى × جميزه 9) لصفة الطرد والنضج والهجين (جيزه 168 × دوبرى) لصفة ارتفاع النبات والهجن (جيزه 168 × جميزه 9) ، (دوبرى × سدس 1) لصفة عدد حبوب السنبلة والهجن (سخا 93 × جميزه 168) ، (أونملى × سدس 1) لصفة محصول الحبوب للنبات تأثيرات معنوية ومرغوبة للقدرة الخاصة على التآلف بالنسبه لمعامل الحساسية للجفاف لهذه الصفات ، ومن الواضح أن الأباء جيزه 168 ودوبرى شاركت فى معظم الهجن المبشرة والمرغوبة تحت ظروف الإجهاد المائى لهذه الصفات.