IV. RESULTS AND DISCUSSION

Breeding and selecting for better wheat yield in water limited environments which occurred by drought and salinity have been accomplished more successfully using traditional breeding methods in environments where water was not limited. This has been due to mainly to the contribution of dwarfing genes that are yield positive in dry environments as well as in the irrigated environments for which they were originally developed. To identify ways to further improve yields in dry environments, two breeding approaches are discussed; the first, the traditional or empirical approach where selection is for yield, and the second, an analytical approach where selection is for a trait other than yield that may be advantageous under drought. Emphasis in the traditional approach is on the best environment in which to select and in the analytical approach on traits that are yield positive in dry environments but unlikely to be yield negative in water environments.

Griffing (1956) noted that parental and F_1 data have distinct advantage over data from segregating generations in studying quantitative genetic systems because, being unaffected by genetic segregation and linkage, the former data require relatively few individuals for estimation genetic parameters. Hence, more parents and wider range of germplasm can be included. Diallel analysis for estimating certain genetic parameters in terms of gene models have been developed and extensively used by plant breeders.

The first study:

The parents and F_1 generation were evaluated under drought conditions, data were recorded on all genotypes for growth, yield components, drought measurements and susceptibility index. Two adjacent experiments were conducted. The first one was non-stress and the second was water stress.

The second study:

The parents and F_2 generation were evaluated under salinity conditions. Also, data were recorded on all genotypes for growth, yield and yield components.

A- The First study (F_1 generation):

For better representation and discussion of the results obtained herein, it was performed to outline these results into three main parts, the first: growth yield and yield components, the second: drought measurements and the third: susceptibility index.

A.1. Growth, yield and yield components:

A.1.1. Analysis of Variance and Means Performance:

The analysis of variance for each of the stress and normal environments as well as the combined data for growth, yield and yield components are presented in (Table 8). The error variance for the two environments were homogenous for all the studied traits, consequently the combined analysis would be valid.

Results indicated that irrigation treatments mean squares were significant for all studied traits, indicating overall differences between the two irrigation treatments (stress and normal).

Results in (Table 9) presented the average of studied traits at both irrigation treatments. It is clear that all studied traits increased significantly with non-stress compared with stress condition.

Highly significant genotypes mean squares were obtained for all studied traits in separate irrigation treatments as well as the combined analysis (Table 8). This indicates the wide diversity between the parental materials which were used in the present study. Significant genotypes × environment mean squares were detected for all studied traits, revealing that the performance of genotypes differed from environment to another.

Also, results showed that mean squares due to parents were significant for all studied traits. Significant mean squares due to interaction between parental varieties and irrigation treatments were detected for all the studied traits except plant height and number of spikes/plant. Such result revealed that the parents varied in their response to environment in these traits.

The mean performance of the seven parental varieties and /or lines of wheat at separate environments as well as the combined data are presented in (Table 9).

The parental variety Yacora Rojo (P_1) gave the lowest values for plant height, flag leaf area, no. of kernels/spike, 1000-kernel weight, straw, grain and biological yields. It gave moderate values for other traits.

The parental variety Sham-6 (P_2) ranked the second highest for flag leaf area, no. of kernels/spike. While, it gave the lowest one for 1000-kernel weight. However, it gave the moderate values for other traits.

The parental ICARDA-3 (P_3) ranked the second of the tested parents for 1000-kernel weight. However, it gave the moderate values for other traits.

The parental variety Giza-168 (P_4) expressed the highest value for no. of kernels/spike. While, it ranked the second of the tested parents for grain yield/plant. However, it almost expressed moderate values for the most of other traits.

The parental variety Sakha-93 (P_5) ranked the second of the tested parents for no. of spikes/plant. While, it gave either moderate or low values for other traits.

The parental variety Gemmiza-7 (P_6) exhibited the highest values for plant height and 1000-kernel weight. While, it gave the lowest values for no. of spikes/plant and harvest index. Meanwhile, it almost expressed moderate values for the most of other traits.

The parental line-606 (P_7) expressed the highest values for flag leaf area, no. of spikes/plant, straw, grain and biological yields/plant. However, it gave moderate values for the most of other traits.

Data presented in (Table 8) showed that crosses mean squares were significant for all studied traits under both environments as well as the combined analysis, revealing an over all differences between these hybrids. Significant mean squares due to interaction between crosses and environments were detected for all the studied traits. Such results indicate that these hybrids varied in their response to environmental fluctuations.

Table (9): The genotypes mean performance for the agronomical traits from the F_1 generation.

Genotypes	Plant height (cm)			Flag leaf area(cm^2)			No. of spikes/plant		
	NS	S	C	NS	S	C	NS	S	C
Yacora Rojo (P_1)	72.17	67.83	70.00	48.43	31.32	39.88	4.93	4.59	4.76
Sham-6 (P_2)	88.17	85.17	86.67	78.57	52.02	65.29	5.25	4.13	4.69
ICARDA-3 (P_3)	88.89	86.27	87.58	49.92	37.50	43.71	5.17	4.37	4.77
Giza-168 (P_4)	89.66	87.03	88.34	40.22	31.45	35.83	5.75	4.12	4.94
Sakha-93 (P_5)	79.59	73.09	76.34	54.99	49.84	52.42	6.12	4.93	5.53
Gemmiza-7 (P_6)	95.00	93.00	94.00	75.04	52.22	63.63	4.87	3.75	4.31
Line-606 (P_7)	94.67	91.22	92.94	72.34	68.00	70.17	7.41	6.42	6.92
$P_1 \times P_2$	81.75	77.30	79.52	78.27	47.25	62.76	6.88	5.52	6.20
$P_1 \times P_3$	84.00	79.13	81.56	50.63	49.75	50.19	7.50	5.50	6.50
$P_1 \times P_4$	85.83	79.25	82.54	59.86	32.50	46.18	7.50	5.38	6.44
$P_1 \times P_5$	76.42	73.37	74.89	47.70	38.07	42.88	7.35	5.67	6.51
$P_1 \times P_6$	83.50	81.75	82.62	60.75	41.07	50.91	7.52	5.17	6.34
$P_1 \times P_7$	87.17	81.79	84.48	66.33	55.56	60.95	6.54	6.17	6.36
$P_2 \times P_3$	94.20	86.67	90.43	65.27	32.95	49.11	7.40	5.84	6.62
$P_2 \times P_4$	90.92	87.89	89.40	56.17	32.63	44.40	6.80	5.52	6.16
$P_2 \times P_5$	91.11	85.92	88.51	66.28	62.28	64.28	8.63	6.44	7.53
$P_2 \times P_6$	90.33	88.33	89.33	63.02	61.55	62.28	8.25	5.95	7.10
$P_2 \times P_7$	93.50	92.65	93.07	68.38	46.50	57.44	8.50	7.00	7.75
$P_3 \times P_4$	90.59	88.98	89.78	60.32	55.58	57.95	7.58	6.79	7.19
$P_3 \times P_5$	88.75	85.59	87.17	57.76	33.28	45.52	6.94	5.87	6.41
$P_3 \times P_6$	90.75	88.00	89.37	70.71	21.04	45.88	7.56	6.25	6.90
$P_3 \times P_7$	85.88	85.33	85.60	68.23	38.83	53.53	7.36	5.62	6.49
$P_4 \times P_5$	88.07	85.02	86.54	60.23	56.06	58.14	6.44	6.06	6.25
$P_4 \times P_6$	94.96	89.42	92.19	70.50	35.61	53.05	6.61	6.25	6.43
$P_4 \times P_7$	96.86	87.17	92.01	64.86	60.64	62.75	8.50	5.76	7.13
$P_5 \times P_6$	92.67	83.61	88.14	56.78	43.88	50.33	7.33	5.31	6.32
$P_5 \times P_7$	84.17	79.50	81.83	53.93	29.97	41.95	6.62	5.50	6.06
$P_6 \times P_7$	96.59	95.59	96.09	62.97	53.25	58.11	7.90	6.50	7.20
Mean of parents	86.877	83.371	85.124	59.93	46.05	52.99	5.644	4.615	5.130
Mean of crosses	88.952	84.869	86.911	62.33	44.20	53.26	7.415	5.908	6.662
Mean of genotypes	88.433	84.495	86.464	61.73	44.66	53.20	6.972	5.585	6.279
L.S.D. $_{0.05}$	2.50	3.21	2.01	3.19	2.62	2.05	1.08	0.60	0.62
L.S.D. $_{0.01}$	3.32	4.27	2.67	4.25	3.49	2.71	1.44	0.80	0.82

NS= Normal irrigation S= Stress condition C= Combined

Table (9): cont.

Genotypes	No. of kernels/spike			1000-kernel weight (g)			Straw yield / plant (g)		
	NS	S	C	NS	S	C	NS	S	C
Yacora Rojo (P_1)	33.35	28.50	30.93	33.15	30.85	32.00	11.99	9.58	10.79
Sham-6 (P_2)	47.31	41.65	44.48	34.02	26.18	30.10	18.63	11.17	14.90
ICARDA-3 (P_3)	42.19	37.94	40.07	39.34	30.28	34.81	17.08	11.12	14.10
Giza-168 (P_4)	50.33	38.91	44.62	38.38	30.50	34.44	18.60	10.51	14.55
Sakha-93 (P_5)	44.25	35.78	40.02	36.35	27.54	31.95	20.27	12.07	16.17
Gemmiza-7 (P_6)	39.62	36.00	37.81	43.75	36.10	39.93	21.57	19.34	20.46
Line-606 (P_7)	41.65	36.54	39.10	34.67	28.72	31.70	15.39	14.72	15.06
P1× P2	45.48	32.29	38.89	37.44	33.62	35.53	25.48	25.55	25.52
P1× P3	35.77	32.42	34.10	39.99	25.59	32.79	19.47	11.09	15.28
P1× P4	43.36	35.95	39.65	35.12	29.12	32.12	16.11	10.60	13.36
P1× P5	37.10	34.88	35.99	33.04	27.25	30.15	14.78	12.54	13.66
P1× P6	40.28	37.17	38.72	46.93	31.64	39.28	20.89	11.23	16.06
P1× P7	48.81	33.56	41.19	41.84	38.33	40.08	25.84	27.11	26.48
P2 × P3	42.77	36.99	39.88	41.74	31.87	36.80	29.27	23.46	26.37
P2× P4	39.12	37.50	38.31	43.07	33.50	38.29	23.77	19.01	21.39
P2 × P5	46.84	32.11	39.48	43.38	36.80	40.09	35.67	22.50	29.09
P2 × P6	46.69	38.50	42.60	41.29	35.22	38.25	30.13	20.27	25.20
P2 × P7	34.56	31.25	32.91	44.68	34.39	39.54	21.02	13.81	17.41
P3 × P4	46.76	40.48	43.62	38.98	31.60	35.29	28.64	27.28	27.96
P3× P5	41.75	38.00	39.88	41.78	32.84	37.31	35.85	25.06	30.46
P3 × P6	44.33	33.25	38.79	43.14	32.87	38.00	28.19	16.19	22.19
P3 × P7	39.99	35.95	37.97	36.08	32.10	34.09	21.63	23.12	22.37
P4 × P5	40.79	39.83	40.31	38.67	32.58	35.63	29.96	28.04	29.00
P4 × P6	44.44	32.79	38.62	43.44	39.97	41.71	23.95	19.48	21.71
P4 × P7	31.57	27.67	29.62	43.28	38.46	40.87	21.94	18.47	20.21
P5 × P6	34.10	31.83	32.97	41.15	33.88	37.52	21.46	15.86	18.66
P5 × P7	47.49	39.21	43.35	39.12	37.44	38.28	20.50	17.71	19.11
P6 × P7	38.03	32.26	35.15	43.33	38.57	40.95	28.78	22.86	25.82
Mean of parents	42.673	36.475	39.574	37.094	30.023	33.559	17.648	12.644	15.146
Mean of crosses	41.430	34.947	38.188	40.833	33.696	37.265	24.921	19.584	22.253
Mean of genotypes	41.741	35.329	38.535	39.898	32.778	36.338	23.103	17.849	20.476
L.S.D. 0.05	1.46	1.23	0.94	1.61	1.46	1.08	1.33	1.07	0.84
L.S.D. 0.01	1.94	1.64	1.25	2.14	1.95	1.43	1.76	1.42	1.11

NS= Normal irrigation S= Stress condition C= Combined

Table (9): cont.

Genotypes	Grain yield / plant (g) NS	Grain yield / plant (g) S	Grain yield / plant (g) C	Biological yield (g) NS	Biological yield (g) S	Biological yield (g) C	Harvest index NS	Harvest index S	Harvest index C
Yacora Rojo (P_1)	5.45	4.03	4.74	17.44	13.62	15.53	31.27	29.63	30.45
Sham-6 (P_2)	8.45	4.50	6.47	27.08	15.66	21.37	31.22	28.71	29.96
ICARDA-3 (P_3)	8.58	5.02	6.80	25.66	16.14	20.90	33.42	31.07	32.25
Giza-168 (P_4)	11.13	4.90	8.01	29.73	15.40	22.56	37.29	31.86	34.58
Sakha-93 (P_5)	9.84	4.86	7.35	30.12	16.92	23.52	32.67	28.73	30.70
Gemmiza-7 (P_6)	8.46	4.87	6.67	30.04	24.21	27.12	28.13	20.11	24.12
Line-606 (P_7)	10.71	6.73	8.72	26.10	21.45	23.78	41.04	31.37	36.21
$P_1 \times P_2$	11.70	6.00	8.85	37.18	31.55	34.36	31.48	18.99	25.24
$P_1 \times P_3$	10.74	4.57	7.66	30.22	15.66	22.94	35.52	29.13	32.32
$P_1 \times P_4$	11.42	5.63	8.52	27.53	16.23	21.88	41.52	34.64	38.08
$P_1 \times P_5$	9.00	5.41	7.21	23.78	17.95	20.87	37.82	30.06	33.94
$P_1 \times P_6$	14.21	6.08	10.15	35.10	17.32	26.21	40.49	34.96	37.72
$P_1 \times P_7$	13.36	7.94	10.65	39.21	35.05	37.13	34.07	22.65	28.36
$P_2 \times P_3$	13.24	6.86	10.05	42.51	30.32	36.42	31.09	22.59	26.84
$P_2 \times P_4$	11.46	6.93	9.20	35.23	25.95	30.59	32.52	26.72	29.62
$P_2 \times P_5$	17.55	7.61	12.58	53.22	30.11	41.66	32.88	25.26	29.07
$P_2 \times P_6$	15.92	8.08	12.00	46.05	28.35	37.20	34.42	28.46	31.44
$P_2 \times P_7$	13.12	7.52	10.32	34.14	21.33	27.73	38.36	35.28	36.82
$P_3 \times P_4$	13.83	8.69	11.26	42.47	35.97	39.22	32.52	24.15	28.33
$P_3 \times P_5$	12.11	7.33	9.72	47.96	32.39	40.17	25.23	22.61	23.92
$P_3 \times P_6$	14.45	6.82	10.64	42.64	23.01	32.82	33.87	29.65	31.76
$P_3 \times P_7$	10.64	6.49	8.56	32.27	29.60	30.94	32.94	21.92	27.43
$P_4 \times P_5$	10.17	7.87	9.02	40.46	35.91	38.18	25.13	21.92	23.52
$P_4 \times P_6$	12.76	8.20	10.48	36.71	27.68	32.20	34.75	29.61	32.18
$P_4 \times P_7$	11.64	6.12	8.88	33.58	24.59	29.09	34.57	24.88	29.73
$P_5 \times P_6$	10.32	5.72	8.02	31.78	21.58	26.68	32.27	26.54	29.40
$P_5 \times P_7$	12.35	8.06	10.20	32.85	25.78	29.31	37.46	31.29	34.38
$P_6 \times P_7$	13.05	8.08	10.57	41.83	30.95	36.39	31.16	26.10	28.63
Mean of parents	8.946	4.987	6.966	26.594	17.630	22.112	33.579	28.783	31.181
Mean of crosses	12.526	6.953	9.739	37.463	26.537	32.000	33.811	27.019	30.415
Mean of genotypes	11.631	6.461	9.046	34.746	24.310	29.528	33.753	27.460	30.607
$L.S.D._{0.05}$	2.10	0.76	1.11	2.60	1.52	1.49	3.90	2.26	2.24
$L.S.D._{0.01}$	2.80	1.01	1.47	3.46	2.03	1.98	5.19	3.01	2.96

NS= Normal irrigation S= Stress condition C= Combined

The mean performance of F_1 hybrids in each treatment as well as the combined over them are presented in (Table 9). For flag leaf area, no. of spikes/plant, no. of kernels/spike, straw yield, grain yield, biological yield, the hybrids were within the range of the performance of parents.

For plant height, the mean values for crosses ranged from 74.89 cm. for Yacora Rojo (P_1) × Sakha-93 (P_5) to 96.09 cm. Gemmiza-7 (P_6) × line-606 (P_7) in the combined analysis.

For seed index, the crosses Yacora Rojo (P_1) × line-606 (P_7), Giza-168 (P_4) × Gemmiza-7(P_6), Giza-168 (P_4) × line-606 (P_7) and Gemmiza-7 (P_6) × line-606 (P_7) had the highest mean values in the combined analysis. However, the cross Yacora Rojo (P_1) × Sakha-93 (P_5) gave the lowest one.

The two crosses Sham-6 (P_2) ×Sakha-93 (P_5) and Sham-6 (P_2) ×Gemmiza-7(P_6) in the combined analysis had the highest grain yield/plant. The high grain yield/plant of the both crosses could be attributed to the high no. of spikes/plant, no. of kernels/spike and 1000-kernel weight. It could be concluded that these crosses would be efficient and promising in wheat breeding programs for improving grain yield.

Heterosis:

Mean squares for parents vs. crosses as an indication to average heterosis overall crosses was significant for all traits in both treatments as well as the combined analysis, except flag leaf area and harvest index in the combined analysis and the non stress experiment, respectively (Table 8). F_1's mean performance were significantly higher than parental means for most traits under study.

Significant mean squares due to interaction between parents vs. crosses and environments were detected for all traits except plant height, no. of kernels/spike, 1000-kernel weight and straw yield/plant.

This result indicates that heterotic effects were affected by environmental changes under study. The results agree with the results reported by **Mani** and **Rao (1975), Marakby *et al*. (1993b), EL-Hennawy (1996), Saad *et al.* (1997), El-Borhamy (2000), Hamada** and **Tawfelis (2001), Awaad (2002), Abd El-Aty** and **Katta (2002), Darwish** and **Ashoush (2003), Abd El-Aty** and **El-Borhamy (2007)** and **El-Marakby *et al.* (2007)**

Heterosis expressed as the percentage deviation of F_1 mean performance from its mid and better parent values for all the studied traits at both environments as well as the combined analysis are presented in (Table 10).

For plant height, ten, sex and twelve hybrids expressed significant positive heterotic effects relative to mid-parent in normal, stress irrigation treatments as well as the combined analysis, respectively. While, two, zero and two crosses exhibited significant positive heterotic effects relative to better parent in the same order. On the other hand, the both crosses ICARDA-3 (P_3) × line-606 (P_7) and Sakha-93 (P_5) × line-606 (P_7) in normal irrigation as well as the combined analysis gave significant negative heterotic effects relative to mid-parent value for plant height. However, ten, twelve and ten hybrids expressed significant negative heterotic effects relative to better-parent at normal, stress irrigation treatments as well as the combined analysis, respectively. Significant positive heterotic effect relative to the taller parent values was also reached by **El-Marakby *et al*. (1993b), Hamada** and **Tawfelis (2001), Abd El-Aty and Katta (2002),** and **Darwish** and **Ashoush (2003).** While**, Mani** and **Rao (1975)** did not found significant heterosis for plant height over the better parent in wheat crosses studied.

Regarding flag leaf area, ten, eight and nine crosses expressed significant positive heterotic effects relative to mid-parent in normal, stress irrigation treatments as well as the combined analysis, respectively. While, three, five and four hybrids gave significant positive heterotic effects relative to better parent in the same order. The cross ICARDA-3 (P_3) × Giza-168 (P_4) had the highest desirable positive heterotic effects in both environments and the combined analysis. **Awaad (2002)** reported that heterosis values were positive and significant for FLA in most studied hybrids.

Regarding number of spikes/plant, eighteen, eighteen and nineteen hybrids expressed significant and positive heterotic effects relative to mid-parent value in normal, stress irrigation treatments as well as the combined analysis, respectively. Also, thirteen, thirteen and sixteen crosses exhibited significant positive heterotic effects relative to better-parent value in the same order. The most desirable heterotic effects relative to either mid-or better parent values were detected for the crosses Sham-6 (P_2) × Gemmiza-7 (P_6), ICARDA-3 (P_3) × Giza-168 (P_4) and ICARDA-3 (P_3) × Gemmiza-7 (P_6) being 55.78 and 51.39, 48.09 and 45.55 and 51.98 and 44.65, respectively. Positive heterotic effect for number of spikes/plant was reached by **Hendawy (1990)**, **Saad *et al*. (1997), Hamada** and **Tawfelis (2001), Abd**

El-Aty and **Katta (2002), Darwish** and **Ashoush (2003).** While, **Hassan** and **Abd El-Moniem (1991)** and **El-Marakby (1993b)** did not find significant heterotic effect for this trait.

For number of kernels/spike, seven hybrids exhibited significant positive heterotic effects relative to mid-parent value in both experiments as well as the combined analysis. In the combined data the best mid-parent heterotic effects were detected in four crosses namely Yacora Rojo (p_1) × Giza-168 (p_4) (4.96), Yacora Rojo (P_1) × Gemmiza-7 (P_6) (12.66), Yacora Rojo (P_1) × line-606 (P_7) (17.63) and Sakha-93 (P_5) × line-606 (P_7) (9.58%). Significant and positive better-parent heterosis effects for number of kernels/spike were obtained in three, two and two crosses in normal, stress soil moisture as well as the combined analysis, respectively. The most desirable better-parent heterosis was detected for the two crosses ICARDA-3 (P_3) × line-606 (P_7) (5.34%) and Sakha-93 (P_5) × line-606 (P_7) (8.32%) in the combined data. Significant positive heterotic effect relative to number of kernels/spike were also reached by **El-Borhamy (2000), Hamada** and **Tawfelis (2001), Abd El-Aty** and **Katta (2002)** and **Darwish** and **Ashoush (2003).**

Concerning thousand kernel weight, fifteen hybrids expressed significant positive heterotic effects relative to mid-parent in both experiments as well as the combined data. Also, ten, thirteen and eleven hybrids from the previous crosses exhibited significant positive heterotic effects relative to better parent value in normal, stress irrigation treatments as well as the combined data, respectively. The most desirable better parent heterosis was detected by the three crosses Yacora Rojo (P_1) ×

line-606 (P_7) (25.25%), Sham-6 (P_2) × Sakha-93 (P_5) (25.48%) and Sham-6 (P_2) × line-606 (P_7) (24.73%) in the combined data. In this connection **Hamada** and **Tawfelis (2001), Abd El-Aty** and **Katta (2002)** and **Darwish** and **Ashoush (2003)** found significant positive useful heterosis in 1000-kernel weight**.** On the other hand **Mani and Rao (1975), Hassan** and **Abd El-Moniem (1991), El-Marakby *et al*. (1993b)** reported that only few or no crosses showed significant heterosis over the mid or better-parent for this trait.

For straw yield/plant, eighteen, sixteen and seventeen hybrids expressed significant positive heterotic effects relative to mid-parent in the normal, stress irrigation treatments as well as the combined data, respectively. While, sixteen, twelve and seventeen and twelve hybrids from the previous crosses exhibited significant positive heterotic effects relative to better parent in the same order. The most desirable heterotic effects relative to better parent were detected for the cross Yacora Rojo (P_1) × Sham-6 (P_2) (71.27%), Yacora Rojo (P_1) × line-606 (P_7) (75.83%), Shasm-6 (P_2) × ICARDA-3 (P_3) (76.98%), Sham-6 (P_2) × Sakha-93 (P_5) (79.90%), ICARDA-3 (P_3) × Giza-168 (P_4) (92.16%), ICARDA-3 (P_3) × Sakha-93 (P_5) (88.37%) and Giza-168 (P_4) × Sakha-93 (P_5) (79.39) in the combined data. **El-Borhamy (2000)** reported that heterosis values were positive and significant for straw yield/plant in most studied hybrids.

Regarding grain yield/plant, fifteen, eighteen and nineteen crosses exhibited significant positive heterotic effects relative to mid-parent in the normal, stress irrigation treatments as well as the combined data, respectively. Also, twelve, sixteen and fourteen hybrids exhibited significant positive heterotic effects relative to better parent in the same order. The highest desirable heterotic effects relative to better parent were detected for the cross Yacora Rojo (P_1) × Gemmiza-7 (P_6) (52.17%), Sham-6 (P_2) × Sakha-93 (P_5) (71.16%), Sham-6 (P_2) × Gemmiza-7 (P_6) (79.91%) and ICARDA-3 (P_3) × Gemmiza-7 (P_6) (56.47%) in the combined data. Several investigators reported significant positive heterotic effects for grain yield/plant. Among those are **Mani** and **Rao (1975), Hendawy (1990), Hassan** and **Abd El-Moniem (1991), El-Marakby *et al*. (1993b), Hamada** and **Tawfelis (2001), Abd El-Aty and Katta (2002), Awaad (2002) and Darwish** and **Ashoush (2003).** On the other hand, **Hassan** and **Abd El-Moniem (1991), El-Marakby *et al*. (1993b)** reported that only few or no crosses showed significant heterosis over the mid or better parent for this trait.

Regarding biological yield/plant, nineteen, eighteen and twenty-one hybrids expressed significant positive heterotic effects relative to mid-parent in the normal, stress irrigation treatments and the combined analysis, respectively. Moreover, eighteen, fourteen and seventeen hybrids exhibited significant positive heterotic effects relative to better parent in the same order. The seven crosses exhibited the most desirable heterotic effects relative to better parent. These crosses were Yacora Rojo (P_1) × Sham-6 (P_2) (60.79%), Yacora Rojo (P_1) × line-606 (P_7) (56.14%), Sham-6 (P_2) × ICARDA-3 (P_3) (70.43%), Sham-6 (P_2) ×Sakha-93 (P_5) (77.13%), ICARDA-3 (P_3) × Giza-168 (P_4) (73.84%), ICARDA-3 (P_3) × Sakha-93 (P_5) (70.79%) and Giza-168 (P_4) ×Sakha-93 (P_5) (62.33%) in the combined analysis.

Concerning harvest index, four, seven and eight crosses expressed significant positive heterotic effects relative to mid-parent in the normal, stress irrigation treatments and the combined analysis, respectively. The two crosses Yacora Rojo (P_1) × Giza-168 (P_4) and Yacora Rojo (P_1) × Gemmiza-7 (P_6) exhibited significant positive heterotic effects relative to either mid-parent or better parent in both irrigation treatments as well as the combined analysis.

The two previous crosses expressed the most desirable heterotic effects relative to better parent in the combined analysis. **El-Borhamy (2000)** reported that heterosis values were positive and significant for harvest index in most studied hybrids.

A.1.2. Combining ability:

Analysis of variance for combining ability as outlined by **Griffing's (1956)** method 2 model 1 in each environment and their combined data for all the studied traits are shown in (Table 11). The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were highly significant for all traits. It is evident that both additive and non-additive gene effects were involved in determining the performance of single cross progeny. Also, when GCA/SCA ratio was used, it was found that number of spikes/plant, in both irrigation treatments as well as the combined analysis, no. of kernels/spike and grain yield/plant in normal irrigation as well as the combined analysis and straw and biological yields/plant and harvest index in stress irrigation treatment as well as the combined analysis, exhibited low GCA/SCA ratio of less than unity indicating the predominance of non-additive gene action in the inheritance of such cases. While, the magnitude of additive and non-additive types of gene action were similar for, no. of kernels/spike and grain yield/plant in normal, stress irrigation as well as the combined analysis, respectively.

On the other hand, high GCA/SCA ratio which exceeded the unity was detected for other cases. Such results indicate that additive and additive by additive types of gene action were more important that non additive gene effects controlling in these cases. The genetic variance was previously reported by **Hendawy (1990), El-Marakby *et al*. (1993a), EL-Hennawy (1996), Darwish (1998), El-Borhamy (2000)** and **El-Gamal (2001).**

The mean squares of interaction between irrigation treatments and general combining ability were significant for all traits except plant height and no. of spikes/plant, indicating that the magnitude of additive and additive by additive types of gene action varied from irrigation treatment to another. For the exceptional traits, insignificant interaction mean squares were obtained, revealing that the magnitude of additive and additive by additive types of gene action did not differ from environment to another.

Significant mean squares of interaction between specific combining ability and irrigation treatments were obtained for all the studied traits revealing that the magnitude of non-additive type of gene action was differ from irrigation treatment to another. Similar results were previously reported by **Singh *et al*. (1982).**

It is fairly evident that ratio for SCA × irrigation treatment/SCA was much higher than ratios of GCA × irrigation treatment/GCA for all traits except straw and biological yields/plant and harvest index. Such results indicate that non-additive effects were much more influenced by the environmental conditions than the additive genetic one. Specific combining ability was stated by several investigators to be more sensitive to environmental changes than GCA **(Gilbert, 1958)**

General combining ability effects ($\hat{g}_i$):

Estimates of GCA effects ($\hat{g}_i$) for individual parental genotypes in each trait in both irrigation treatment as well as the combined data are presented in (Table 12). Results indicate that P_1 Yacora Rojo seemed to be good combiner for harvest index. It, on the contrary, expressed significant negative $\hat{g}_i$ effects for the other traits. Such results indicate that the parental variety P_1 Yacora Rojo could be considered as excellent combiner for developing high harvest index of genotypes.

The parental variety Sham-6 (P_2) expressed significant positive $\hat{g}_i$ effects for plant height, flag leaf area, number of kernels/spike, straw yield/plant and biological yield/plant in both irrigation treatments as well as the combined analysis and grain yield/plant in normal irrigation and the combined analysis, revealing that this parent was best combiner for these traits.

The parental ICARDA-3 (P_3) expressed significant positive $\hat{g}_i$ effects for straw and biological yields/plant in both irrigation treatments as well as the combined analysis, plant height and no. of kernels/spike under stress irrigation and the combined analysis.

The parental variety Giza-168 (P_4) expressed significant positive $\hat{g}_i$ effects for plant height and no. of kernels/spike in both irrigation treatments as well as the combined analysis, 1000-kernel weight and harvest index under stress irrigation and the combined analysis. However, it exhibited either significant negative or insignificant $\hat{g}_i$ effects for other traits.

The parental variety Sakha-93 (P_5) expressed significant positive $\hat{g}_i$ effects for straw yield/plant in both irrigation treatments and the combined analysis, no. of kernels/spike in stress irrigation treatment and the combined analysis, biological yield/plant under normal irrigation treatment and the combined analysis and flag leaf area under stress irrigation treatment. Also, parental variety P_5 ranked the second best combiner for short plant height.

The parental variety Gemmiza-7 (P_6) seemed to be good general combiner for 1000-kernel weight in both irrigation treatments as well as the combined analysis. Also, it exhibited significant positive $\hat{g}_i$ effects for plant height, under both irrigation treatments as well as the combined data, flag leaf area, straw, grain and biological yields/plant under normal irrigation treatment and the combined analysis.

The parental line Line-606 (P_7) seemed to be the best general combiner for flag leaf area, no. of spikes/plant and harvest index in both irrigation treatments as well as the combined analysis. Also, it expressed significant positive $\hat{g}_i$ effects for plant height in irrigation treatments as well as the combined analysis, 1000-kernel weight, grain and biological yields/plant under stress irrigation and the combined analysis and straw yield/plant under stress irrigation treatment. This mean that this parent could be considered the best combiner for grain, straw and biological yields, 1000-kernel weight, no. of spikes/plant, flag leaf area and higher plant in stress irrigation treatments.

Significant positive correlation coefficient values between parental performance and its $\hat{g}_i$ effects were obtained for plant height, flag leaf area, no. of spikes/plant and no. of kernels/spike in both irrigation treatments as well as the combined analysis, 1000-kernels weight and straw yield/plant under normal irrigation, grain yield/plant under stress irrigation and the combined analysis and biological yield/plant under normal irrigation as well as the combined analysis, (Table 12). These findings indicate that the parental genotypes gave a good index of intrinsic performance of their $\hat{g}_i$ effects. Therefore, selection among the tested parental population for initiating any proposed breeding program could be practiced either on mean performance or $\hat{g}_i$ effect basis with similar efficiency.

For other cases, insignificant correlation coefficient values were detected between the two variables. This disagreement revealed that hybrids characterized with high values could be expected for these cases. This result may be due to high magnitude of non-additive gene effects in these cases (Table 11). A rather good agreement between ranking of parental performance was reported by **Singh *et al.* (1982), Nada *et al.* (1983)** and **El-Borhamy (2000) .**

Specific combining ability effects (S_{ij}):

Specific combining ability effects of the parental combinations were computed for all traits in the F_1 generation in both irrigation treatments as well as the combined analysis are presented in (Table 13).

For plant height, nine, five and ten crosses exhibited significant positive S_{ij} effects in normal, stress irrigation treatment as well as the combined analysis, respectively. The both crosses Sham-6 (P_2) × Sakha-93 (P_5) and ICARDA-3 (P_3) × Sakha-93 (P_5) gave the highest S_{ij} values in both irrigation treatments as well as the combined analysis. However, five, two and five crosses exhibited significant negative S_{ij} effects under normal, stress irrigation treatments as well as the combined analysis, respectively. The two crosses ICARDA-3 (P_3) × Line-606 (P_7) and Sakha-93 (P_5) × line-606 (P_7) exhibited the best negative S_{ij} values in normal, stress conditions and the combined over them.

Regarding flag leaf area, eleven, eight and seven crosses expressed significant positive S_{ij} effects in normal, stress irrigation treatments as well as the combined analysis, respectively. The crosses ICARDA-3 (P_3) × Giza-168 (P_4), Giza-168 (P_4), × Sakha-93(P_5), Yacora Rojo (P_1) × Sham-6 (P_2) and Sham-6 (P_2) × Sakha-93 (P_5) gave the most desirable S_{ij} effects for this trait. It is clear that the previous four crosses are the promising in practical breeding programs to produce broader flag leaf area genotypes. However, eight, nine and eight crosses exhibited significant negative S_{ij} effects in normal, stress irrigation treatments and the combined analysis, respectively.

The crosses Sakha-93 (P_5) × line-606 (P_7) and Sham-6 (P_2) × Giza-168 (P_4) expressed the best negative S_{ij} effects for this trait.

Regarding no. of spikes/plant, ten, eight and thirteen hybrids expressed significant positive S_{ij} effects in the normal, stress irrigation treatments and the combined over them, respectively. Results indicates that the crosses Sham-6 (P_2) × Sakha-93 (P_5), Sham-6 (P_2) × Gemmiza-7 (P_6), Sham-6 (P_2) × line-606 (P_7), ICARDA-3 (P_3) × Giza-168 (P_4) and ICARDA-3 (P_3) × Gemmiza-7 (P_6) had the best desirable S_{ij} effects for this trait in both irrigation treatments and the combined analysis.

Ten, eight and seven parental combinations exhibited significant positive S_{ij} effects for number of kernels/spike in the normal, stress irrigation treatments and the combined analysis, respectively. Also, the best combinations were Yacora Rojo (P_1) × line-606 (P_7) followed by Sakha-93 (P_5) × line-606 (P_7) in both environments and the combined analysis.

Nine, nine and twelve parental combinations expressed significant positive S_{ij} effects for1000-kernel weight in the normal, stress irrigation treatments and the combined analysis, respectively. The best cross was Yacora Rojo (P_1) × line-606 (P_7) followed by cross Sham-6 (P_2) × Sakha-93 (P_5) and then by cross Giza-168 (p_4) × line-606 (p_7) for this trait.

Concerning straw yield/plant, ten, eleven and eleven crosses expressed significant positive S_{ij} effects in the normal, stress irrigation treatments as well as the combined analysis, respectively. Meanwhile, the most desirable S_{ij} effects were recorded for the crosses Yacora Rojo (P_1) × line-606 (p_7), ICARDA-3 (P_3) × Sakha-93 (P_5), Yacora Rojo (P_1) × Sham-6 (P_2) and Giza-168 (P_4) × Sakha-93 (p_5).

For grain yield/plant, six, nine and eleven crosses expressed significant positive S_{ij} effects in the normal, stress irrigation treatments and the combined analysis, respectively. The cross Sham-6 (P_2) × Sakha-93 (P_5) (5.36) in normal irrigation, the cross ICARDA-3 (P_3) × Giza-168 (P_4) (2.16) in stress irrigation and the cross Sham-6 (P_2) × Sakha-93 (p_5) (3.24) in the combined analysis, ranked the first best for S_{ij} effects.

Eleven crosses exhibited significant positive S_{ij} effects for total yield/plant in each irrigation treatments or the combined analysis. The highest significant desirable S_{ij} effects were obtained by crosses Yacora Rojo (P_1) × line-606 (P_7), ICARDA-3 (P_3) × Giza-168 (P_4), Giza-168 (P_4) × Sakha-93 (P_5), ICARDA-3 (P_3) × Sakha-93 (P_5) and Sham-6 (P_2) × Sakha-93 (P_5) for this trait especially in stress irrigation and the combined analysis.

Five, eight and nine parental combinations expressed significant positive S_{ij} effects in the normal, stress irrigation treatments as well as the combined analysis for harvest index, respectively. The highest significant desirable S_{ij} effects were recorded by crosses Yacora Rojo (P_1) × Gemmiza-7 (P_6), Sham-6 (P_2) × line-606 (P_7) and Yacora Rojo (P_1) × Giza-168 (P_4) for this trait in separate irrigation treatments as well as the combined data.

The previous parental combinations might be of interest in breeding programs aimed at producing pure line varieties for high biological, grain and straw yields/plant and some of its

components, as most combinations involved at least one good combiner for most previous traits.

If crosses showing high specific combining ability effects involving only one good combiner, such combinations would throw out desirable transgressive segregates, providing that the additive genetic system present in the good combiner and complementary and epistatic effects present in the crosses, act in the same direction to reduce undesirable plant characteristics and maximize the character in view. Therefore, the most previous crosses might be prime importance in breeding program to drought tolerant varieties by using traditional breeding procedures.

A.2. Drought measurements:

A.2.1. Analysis of variance, means and heterosis:

Mean squares for stomatal resistance during flower (SRDF), transpiration rate during flower (TRDF), leaf temperature during flower (LTDF), relative water content (RWC) and potassium content (K^+). For each of the two irrigation treatments (normal and stress irrigation) as well as the combined analysis are presented in (Table 14).

Results indicated that irrigation mean squares were highly significant for all the studied traits, indicating overall differences between normal and stress condition. Except for TRDF and RWC mean values of stress condition for all drought measurements were higher than those of normal irrigation, indicating that selection for stress tolerance should give a positive yield response under stress. Also, the results indicated that selection under irrigated environment would be less effective for improving grain yield under drought stress than direct selection in the stress condition. **Atlin** and **Frey (1989)** demonstrated that grain yield in stress or low-productivity environments were not controlled by the same genes, making indirect selection unattractive. Also, results indicated that mean values of normal environment for yield and its components were higher than those of stress condition.

Mean squares for genotypes, parents, crosses and parent vs. crosses were significant for all traits in both environments as well as the combined analysis, except parents mean square for LTDF in stress condition, parent vs. crosses for SRDF in the combined analysis and TRDF, LTDF and RWC in stress conditions, indicating wide diversity between the parental used in the present study for these traits.

Genotypes × irrigation, parent × irrigation, F_1× irrigation and parent vs. crosses× irrigation were significant for all traits except parent × irrigation for LTDF, crosses × irrigation for SRDF and parent vs. crosses× irrigation for LTDF and K^+ content. Such results indicated that the tested genotypes varied from each other and ranked differently from normal to stress irrigation treatments.

A. 2. 1.1. Stomatal resistance (SR):

Data presented in (Table 15) clearly show that during occurrence of water stress, stomatal resistance (SRDF) increased considerably. The highest mean values of (SRDF) under stress condition were recorded with ICARDA-3 (P3) × Giza-168 (P4) (5.80), followed by cross Sham-6 (P_2) × line-606 (P_7) (5.73) and then by Giza-168 (P_4) (5.4). While, the crosses Sham-6 (P_2) ×

ICARDA-3 (P_3) (3.3), Gemmiza-7(P_6) × line-606(P_7) (3.26) recorded lowest SRDF values. Moreover, the other genotypes recorded moderate SRDF values. Similar results were found by **El-Gamal (2001)** who mentioned that, the increase in stomatal resistance under water stress condition was due to the stomatal closure. This is commonly found in many species and may indicate a control of stomatal conductance through hydraulic fed back mechanism **(Giorio *et al.*, 1999)**. Moreover, **(West *et al.*, 1990)** showed that, the drought resistance cultivar had a significant higher stomatal resistance than the drought sensitive cultivar. The drought resistant plants closed their stomata in response to the slight water stress condition, while the drought sensitive plants kept their stomata open. However, **Shimshi** and **Ephart (1975)** suggested that the prometer method would be useful in wheat breeding programs. The study showed that stomatal resistance was the best method to use to screen plant for drought resistance.

A. 2. 1. 2. Transpiration rate (TR) and leaf temperature (LT):

Results in (Table 15) showed that water treatments had significant effect on transpiration rate and leaf temperature overall bread wheat genotypes were the water stress decreased TR by 50.63% and increased LT by 4.92%. The rise of leaf temperature under water stress conditions may be due to the decrease in transpiration rate as compared with normal irrigation. Similar results were obtained by **Wiegand and Namken (1966), Ehrler (1973), Shimshi and Ephrat (1975), Ehrler *et al*. (1978)** and **El-Gamal (2001).** They added that stomatal closure results in increased leaf temperature if other relevant factors, like wind speed and vapor pressure remain relatively constant.

The mean performance of the seven parents and twenty-one hybrids of wheat at stress and normal irrigation in (Table 15) showed that the parental Sakha-93 (P_5) had the lowest mean values for TR followed by Yacora Rojo (P_1), Sham-6 (P_2) and line-606 (P_7) and the highest mean values observed by ICARDA-3 (P_3) and Giza-168 (P_4). Also, the lowest values were obtained from crosses Giza-168 (P_4) × Sakha-93 (P_5), ICARDA-3 (P_3) × line-606 (P_7), Sham-6 (P_2) × ICARDA-3 (P_3) and Gemmiza-7(P_6) × line-606 (P_7) in stress conditions. While, the crosses Yacora Rojo (P_1) × Giza-168 (P_4), Yacora Rojo (P_1) × line-606 (P_7), Sham-6 (P_2) × Gemmiza-7(P_6), ICARDA-3 (P_3) × Gemmiza-7(P_6) and Giza-168 (P_4) × line-606 (P_7) had the greatest values. The cross Giza-168 (P_4) × Gemmiza-7(P_6) and ICARDA-3 (P_3) had the lowest LT values in stress condition. **Zhongjin** and **Neumann (1998)** reported that drought environments lead to inhibition of leaf growth by water stress, which can be considered to be an adaptive response. Thus, it limits leaf area production and eventually per plant rates of transpiration. Reduced transpiration may then prolong plant survival by extending the period of availability of essential soil water reserves. **Misra** and **Gangwar (1990)** and **West *et al*. (1990)** showed that, transpiration rate is the important criteria to be used for screening a large number of germplasm for drought resistance.

Table (15): The genotypes mean performance for drought measurements studied on F_1 generation.

Genotypes	Stomatal resistance during flower (SRDF)			Transpiration rate during flower (TRDF)			Leaf temperature during flower (LTDF)		
	NS	S	C	NS	S	C	NS	S	C
Yacora Rojo (P_1)	2.24	3.70	2.97	6.50	5.11	5.80	24.00	24.70	24.35
Sham-6 (P2)	3.02	4.02	3.52	7.97	3.71	5.84	23.70	25.00	24.35
ICARDA-3 (P3)	2.99	4.36	3.67	10.78	5.77	8.27	23.27	24.20	23.73
Giza-168 (P4)	4.31	5.40	4.85	8.57	7.57	8.07	23.07	24.50	23.78
Sakha-93 (P5)	1.91	4.89	3.40	8.42	0.42	4.42	23.70	24.40	24.05
Gemmiza-7 (P6)	2.15	4.50	3.32	7.75	5.17	6.46	24.30	24.90	24.60
Line-606 (P7)	1.61	5.40	3.50	7.32	4.36	5.84	23.20	24.90	24.05
$P_1 \times P_2$	2.47	4.08	3.27	9.59	2.74	6.16	22.83	24.40	23.62
$P_1 \times P_3$	3.21	4.19	3.70	8.92	5.64	7.28	23.10	24.27	23.68
$P_1 \times P_4$	3.37	4.22	3.79	8.54	6.58	7.56	23.60	24.97	24.28
$P_1 \times P_5$	3.00	3.49	3.24	9.06	4.16	6.61	23.80	24.50	24.15
$P_1 \times P_6$	2.71	4.44	3.57	7.62	3.99	5.81	23.00	24.30	23.65
$P_1 \times P_7$	2.94	4.45	3.69	9.91	6.32	8.12	23.70	24.07	23.88
$P_2 \times P_3$	2.75	3.30	3.02	8.17	1.74	4.95	23.30	24.30	23.80
$P_2 \times P_4$	3.10	3.85	3.48	8.99	3.31	6.15	23.57	24.50	24.03
$P_2 \times P_5$	2.57	4.25	3.41	9.60	4.21	6.90	24.00	24.40	24.20
$P_2 \times P_6$	3.87	4.93	4.40	9.68	6.92	8.30	23.20	24.50	23.85
$P_2 \times P_7$	4.16	5.73	4.94	11.12	5.75	8.43	24.25	24.60	24.43
$P_3 \times P_4$	4.84	5.80	5.32	9.44	4.74	7.09	22.70	24.30	23.50
$P_3 \times P_5$	2.57	3.61	3.09	8.66	3.71	6.19	23.15	24.20	23.68
$P_3 \times P_6$	3.05	4.66	3.85	9.80	6.81	8.30	23.10	24.67	23.88
$P_3 \times P_7$	2.71	3.74	3.23	8.63	0.91	4.77	22.65	24.67	23.66
$P_4 \times P_5$	3.39	3.68	3.54	8.26	0.56	4.41	22.75	24.20	23.48
$P_4 \times P_6$	2.40	3.50	2.95	10.51	4.79	7.65	23.00	24.00	23.50
$P_4 \times P_7$	2.26	3.60	2.93	9.81	6.36	8.09	23.35	24.80	24.08
$P_5 \times P_6$	2.92	3.98	3.45	10.91	4.94	7.93	23.30	24.90	24.10
$P_5 \times P_7$	2.36	3.63	3.00	7.68	5.54	6.61	23.25	24.80	24.03
$P_6 \times P_7$	2.31	3.26	2.78	7.32	1.19	4.26	23.67	24.80	24.23
Mean of parents	2.603	4.610	3.606	8.186	4.588	6.387	23.605	24.657	24.131
Mean of crosses	2.997	4.112	3.554	9.152	4.329	6.740	23.298	24.483	23.890
Mean of genotypes	2.898	4.236	3.567	8.911	4.394	6.652	23.375	24.526	23.951
L.S.D. $_{0.05}$	0.70	0.91	0.57	1.01	1.55	0.91	0.61	0.57	0.41
L.S.D. $_{0.01}$	0.94	1.21	0.76	1.34	2.06	1.21	0.81	0.76	0.55

NS= Normal irrigation S= Stress condition C= Combined

Table (15): cont.

Genotypes	Relative water content (RWC)			K^+ content m/g		
	NS	S	C	NS	S	C
Yacora Rojo (P_1)	23.58	21.40	22.49	34.60	45.16	39.88
Sham-6 (P_2)	16.98	15.19	16.08	33.49	50.54	42.01
ICARDA-3 (P_3)	17.86	15.15	16.51	42.93	50.18	46.55
Giza-168 (P_4)	22.80	15.13	18.97	41.82	45.14	43.48
Sakha-93 (P_5)	14.04	11.80	12.92	32.21	43.49	37.85
Gemmiza-7 (P_6)	13.82	11.97	12.90	36.24	45.72	40.98
Line-606 (P_7)	13.53	9.39	11.46	33.49	42.38	37.93
$P_1 \times P_2$	19.27	14.17	16.72	34.59	46.28	40.43
$P_1 \times P_3$	19.84	14.60	17.22	35.16	46.28	40.72
$P_1 \times P_4$	22.28	16.14	19.21	40.70	44.90	42.80
$P_1 \times P_5$	22.37	15.17	18.77	37.87	47.95	42.91
$P_1 \times P_6$	15.05	12.53	13.79	34.05	51.77	42.91
$P_1 \times P_7$	26.97	13.94	20.46	37.36	49.62	43.49
$P_2 \times P_3$	21.49	13.68	17.59	42.38	50.74	46.56
$P_2 \times P_4$	19.72	16.39	18.06	41.37	50.45	45.91
$P_2 \times P_5$	14.03	12.52	13.28	48.03	48.61	48.32
$P_2 \times P_6$	15.60	12.79	14.20	42.36	48.24	45.30
$P_2 \times P_7$	15.76	13.45	14.61	44.05	47.05	45.55
$P_3 \times P_4$	18.97	10.67	14.82	46.84	49.62	48.23
$P_3 \times P_5$	24.50	14.87	19.69	43.48	48.47	45.97
$P_3 \times P_6$	31.12	14.36	22.74	33.90	48.51	41.20
$P_3 \times P_7$	19.07	14.63	16.85	35.17	44.05	39.61
$P_4 \times P_5$	13.23	12.07	12.65	39.59	47.39	43.49
$P_4 \times P_6$	21.98	9.51	15.75	33.18	46.83	40.01
$P_4 \times P_7$	11.44	10.90	11.17	33.46	41.82	37.64
$P_5 \times P_6$	17.71	14.57	16.14	41.82	46.83	44.32
$P_5 \times P_7$	25.22	17.27	21.25	35.13	54.39	44.76
$P_6 \times P_7$	15.57	13.51	14.54	36.80	52.41	44.60
Mean of parents	17.515	14.291	15.903	36.396	46.086	41.241
Mean of crosses	19.581	13.703	16.642	38.917	48.199	43.558
Mean of genotypes	19.064	13.850	16.457	38.287	47.671	42.979
$L.S.D._{0.05}$	2.25	1.91	1.46	3.41	5.88	3.37
$L.S.D._{0.01}$	2.99	2.55	1.94	4.54	7.82	4.46

NS= Normal irrigation S= Stress condition C= combined

A. 2. 1. 3. Relative water content (RWC):

Data in (Table 15) indicate that, generally there was a gradual decrease in relative water content (RWC) with increasing water stress condition in root media of parents and their crosses. The minimum reduction was in Yacora Rojo (P_1), Sham-6 (P_2), ICARDA-3 (p_3), Yacora Rojo (P_1) × Sham-6 (P_2), Yacora

Rojo (P_1) × ICARDA-3 (P_3), Sham-6 (P_2) × Giz168 (P_4), Sham-6 (P_2) × line-606 (P_7), ICARDA-3 (P_3) × line-606 (P_7), Giza-168 (P_4) × Sakha-93 (P_5) and Gemmiza-7 (P_6) × line-606 (P_7). Meanwhile the maximum reduction was in Giza-168 (P_4), ICARDA-3 (P_3) × Sakha-93 (P_5), ICARDA-3 (P_3) × Gemmiza-7 (P_6) and Giza-168 (P_4) × Gemmiza-7 (P_6).

A. 2. 1. 4. Potassium content (K^+):

It is found the obtained results (Table 15) that, water stress increased gradually the concentration of K^+ in leaves. The increment in leaves in leaves of wheat plants recorded with water stress treatment reached about 24.51% for all genotypes, 26.62 for parents and 32.45 for crosses. These results are in a good line with those reported by **Jones *et al*. (1980)** who showed that K^+ was the major cation contributing to osmotic adjustment in sorghum and **Morgan (1992)** reported that lines exhibiting high osmotic adjustment did so largely (78%) through K^+ accumulation**.**

A. 2. 2. Heterosis:

Mean squares for parent vs. crosses as an indication to average heterosis overall crosses were significant for all drought measurements in both irrigation treatments as well as the combined analysis, except SR in the combined analysis, TR, LT and RWC in stress condition (Table 14). The F_1 mean performances were significantly higher than parental means for most traits (Table 15).

Heterosis expressed as the percentage deviation of F_1 mean performance from either mid-parent or better-parent average values for all the studied measurements at both irrigation treatments as well as the combined analysis are presented in (Table 16).

With regard to stomatal resistance (SR), six, two and three hybrids expressed significant positive heterotic effects relative to mid-parent value at normal, stress irrigation as well as the combined analysis, respectively. Also, four, zero and two crosses expressed significant positive heterotic effects relative to better-parent value in the same order. The two crosses Sham-6 (P_2) × Gemmiza-7(P_6) and Sham-6 (P_2) × line-606 (P_7) gave the most desirable heterotic effects in both irrigation treatments and the combined analysis for this trait.

For transpiration rate (TR), two, eight and six exhibited significant negative heterotic effects relative to mid-parent value in normal, stress irrigation treatments as well as the combined analysis, respectively. On the other hand, zero, three and three from the previous crosses expressed significant negative heterotic effects relative to better-parent value in the same order. The most desirable heterotic effects for TR was recorded by crosses Gemmiza-7 (P_6) × line-606 (P_7), ICARDA-3 (P_3) × line-606 (P_7) and Sham-6 (P_2) × ICARDA-3 (P_3). On the basis of the above discussed data, the decrease in the TR can be considered a survival mechanism in dry conditions. To optimize yield, the plant must keep its stomata open during stress, so that it receives better water and nutrient absorption from the soil. In this case, such genotypes can be considered drought resistant, its suggested that transpiration rate and diffusive resistance could be used for screening wheat cultivars for drought resistance**.**

For leaf temperature (LT), nine, three and six hybrids exhibited significant negative heterotic effects relative to mid-parent value in normal, stress irrigation treatments as well as the combined analysis, respectively. While, two, one and three crosses from the previous hybrids expressed significant negative heterotic effects relative to better-parent in the same order. The most desirable negative heterotic effects were recorded in cross Yacora Rojo (P_1) × line-606 (P_7) in stress environment.

With respect to relative water content (RWC), nine, four and eight crosses surpassed the mid-parent value in normal, stress irrigation treatments as well as the combined analysis, respectively. While, six, two and five crosses exhibited significant positive heterotic effects relative to better-parent value in the same order. The most desirable heterotic effect was recorded in crosses Sakha-93 (P_5) × Gemmiza-7 (P_6) and Sakha-93 (P_5) × line-606 (P_7) in stress environment.

For Potassium (K^+) content, ten, four and eleven crosses exhibited significant positive heterotic effects relative to mid-parent value in normal, stress irrigation treatments as well as the combined analysis, respectively. Also, five, three and five crosses from the previous crosses expressed significant positive heterotic effects relative to better-parent in the same order. The

most desirable heterotic effect was recorded by the three crosses Sakha-93 (P_5) × Gemmiza-7 (P_6) followed by the cross Sakha-93 (P_5) × line-606 (P_7) and then by the cross Yacora Rojo (P_1) × Gemmiza-7 (P_6) in stress condition.

Clarke and **McCaing (1982)** found differences in excised leaf water loss rate between cultivars.

In all drought measurements, the values of heterosis were mostly differed from irrigation treatment to another. This finding coincided with that reached above where significant genotypes by environment and its components were significant (Table 14).

<u>A.2.3. Combining ability:</u>

(Table 17) presents the mean squares for general combining ability (GCA), specific combining ability (SCA) and ratios for the studied drought measurements in both irrigation treatments (normal and stress irrigation) and the combined over them.

The mean squares associated with general combining ability (GCA) were significant for all drought measurements in both irrigation treatments as well as the combined analysis except stomatal resistance (SR), leaf temperature (LT) and potassium (K^+) content in stress irrigation. While, mean squares due to specific combining ability (SCA) were significant for all drought measurements under study.

It is evident that non-additive type of gene action was the more important part of the total genetic variability for stomatal resistance (SR), leaf temperature (LT) and potassium (K^+) content under stress irrigation. For the other studied drought measurements, both additive and non-additive gene effects were involving in determining the performance of single cross progeny. Also, when GCA/SCA ratio was used, it was found that, stomatal resistance (SR) in stress irrigation as well as the combined analysis, transpiration rate (TR) in both irrigation treatments as well as the combined analysis, (RWC) in normal irrigation and potassium (K^+) content in the stress conditions exhibited low GCA/SCA ratios of less than unity, indicating the predominance of non-additive gene action in the inheritance of such traits. While, the magnitudes of additive and non-additive types of gene action were similar for relative water content (RWC), transpiration rate (TR) and stomatal resistance (SR) in the normal, stress irrigation treatments as well as the combined analysis, respectively. On the other hand, high GCA/SCA ratio, which exceeded than the unity was obtained for other cases. Such results indicate that additive and additive by additive gene action were more important than non-additive gene effects controlling in these cases. These results were along the same line of **El-Marakby *et al*., (1993a),** and **Darwish (1998),** who found equal importance of additive and non additive effects for most traits. Also, **Abd El-Aty** and **Katta (2002)** found that additive gene effects were larger in magnitude than those of dominant ones for yield and its components. Also, **EL-Hennawy (1996), El-Marakby *et al*., (1993a), Darwish (1998), El-Borhamy (2000)** and **El-Gamal (2001),** revealed that high ratios of GCA/SCA mean squares were obtained for almost all characters, indicating there dominant role of additive gene action in the inheritance of these characters.

With the exception of (SR) and (TR), it is fairly evident that ratios for SCA × E/SCA was much higher than ratios of GCA × E/GCA for other drought measurements. Such results indicated that non-additive effects were much more influenced by the environmental conditions than the additive genetic ones. Specific combining ability was stated by **Gilbert, (1958)** to be more sensitive to environmental changes than GCA. **El-Gamal (2001)** found that the mean squares of interaction between irrigation and both types of combining ability were significant for leaf temperature (LT), relative water content (RWC) and stomatal resistance (SR).

<u>A.2.3. 1. General combining ability effects:</u>

General combining ability effects ($\hat{g}_i$) of each parent for all studied measurements at normal, stress irrigation as well as the combined analysis are presented in (Table 18). Such results are being used to compare the average performance of each variety with other genotypes and facilitate selection of varieties for further improvement to drought resistance.

The parent variety Yacora Rojo (P_1) seemed to be good general combiner for relative water content (RWC) in both irrigation treatments as well as the combined analysis. Also, it gave desirable $\hat{g}_i$ effect for transpiration rate (TR) in normal irrigation.

The parent variety Sham-6 (P_2) expressed significant desirable $\hat{g}_i$ effects for stomatal resistance (SR) and Potassium (K^+) content in the normal irrigation and the combined analysis and transpiration rate (TR) in stress irrigation. Also, it seems to be good combiner for Potassium (K^+) content. While, it gave either significant undesirable or insignificant $\hat{g}_i$ effects for other cases.

The parent variety ICARDA-3 (P_3) expressed significant positive $\hat{g}_i$ effects for stomatal resistance (SR), relative water content (RWC), and potassium (K^+) content in the normal irrigation as well as the combined analysis. Also, it seemed to be the best combiner for leaf temperature (LT) in both irrigations as well as the combined analysis.

The parent variety Giza-168 (P_4) seemed to be a good combiner for stomatal resistance (SR) in the normal treatment and the combined analysis. Also, it expressed significant desirable $\hat{g}_i$ effects for leaf temperature (LT) in normal irrigation as well as the combined analysis and Potassium (K^+) content in normal irrigation treatment. Also, it almost expressed moderate values for the most of other measurements.

The parent variety Sakha-93 (P_5) seemed to be the best general combiner for transpiration rate (TR) in the stress irrigation and the combined analysis. It could be considered as an excellent parent in breeding programs towards releasing varieties characterized by low transpiration rate (TR). While, it almost expressed moderate $\hat{g}_i$ values for the most other measurements.

The parent variety Gemmiza-7 (P_6) expressed undesirable either significant or insignificant $\hat{g}_i$ effects for all measurements in both irrigation treatments and the combined analysis.

The parent line-606 (P_7) expressed significant negative $\hat{g}_i$ effects for transpiration rate (TR) in normal irrigation as well as the combined analysis. While, it gave undesirable significant or insignificant for other measurements.

Significant positive correlation coefficient values between parental performance and its ($\hat{g}_i$) effects were obtained for transpiration rate (TR) in normal, stress irrigation treatments and the combined analysis, relative water content (RWC) in stress irrigation and the combined analysis, leaf temperature (LT) in the combined analysis and stomatal resistance (SR) in normal irrigation and the combined analysis (Table 18). This finding indicates that parental genotypes gave good indexes of intrinsic performance or $\hat{g}_i$ effects. Therefore, selection among the tested parental population for initiation any proposed breeding program could be practiced either on mean performance or $\hat{g}_i$ effects basis with similar efficiency.

For other cases, insignificant correlation coefficient values were detected between the two variables. Such results might add another that both types of genetic variance are important for these traits and coincides with the findings reached above (Table 17).

A.2.3. 2. Specific combining ability effects:

Specific combining ability effects of the parental combinations were computed for all the studied measurements in the F_1 under normal, stress irrigation treatments and the combined analysis over them (Table 19).

Six, three and four crosses for stomatal resistance (SR), six, seven and six crosses for transpiration rate (TR), five, two and five crosses for leaf temperature (LT), eight, six and seven crosses for relative water content (RWC) and eight, three and six

Table (19): Estimates of specific combining ability effects for drought measurements studied on F_1 generation.

Crosses	Stomatal resistance during flowering (SRDF)			Transpiration rate during flowering (TRDF)			Leaf temperature during flowering (LTDF)		
	NS	S	C	NS	S	C	NS	S	C
$P_1 \times P_2$	-0.51*	-0.01	-0.26	1.00**	-1.82**	-0.41	-0.83**	-0.15	-0.49**
$P_1 \times P_3$	0.21	0.12	0.16	0.09	0.75	0.42	-0.12	-0.07	-0.09
$P_1 \times P_4$	0.05	-0.01	0.02	-0.01	0.98*	0.49	0.32	0.52**	0.42**
$P_1 \times P_5$	0.50*	-0.40	0.05	0.70*	0.51	0.60*	0.24	0.05	0.15
$P_1 \times P_6$	0.11	0.40	0.25	-0.78*	-1.33**	-1.05**	-0.59**	-0.28	-0.43**
$P_1 \times P_7$	0.52*	0.25	0.38*	1.76**	1.47**	1.61**	0.18	-0.57**	-0.20
$P_2 \times P_3$	-0.56*	-0.98**	-0.77**	-1.37**	-2.31**	-1.84**	0.03	-0.12	-0.05
$P_2 \times P_4$	-0.53*	-0.59*	-0.56**	-0.28	-1.45**	-0.86**	0.23	-0.03	0.10
$P_2 \times P_5$	-0.24	0.14	-0.05	0.52	1.40**	0.96**	0.38	-0.14	0.12
$P_2 \times P_6$	0.96**	0.68*	0.82**	0.56	2.44**	1.50**	-0.44*	-0.16	-0.30**
$P_2 \times P_7$	1.42**	1.31**	1.37**	2.25**	1.73**	1.99**	0.67**	-0.13	0.27*
$P_3 \times P_4$	1.19**	1.38**	1.29**	-0.06	-0.35	-0.20	-0.19	-0.02	-0.11
$P_3 \times P_5$	-0.26	-0.47	-0.37*	-0.65*	0.57	-0.04	-0.02	-0.12	-0.07
$P_3 \times P_6$	0.12	0.42	0.27	0.45	1.99**	1.22**	-0.10	0.21	0.06
$P_3 \times P_7$	-0.04	-0.65*	-0.35*	-0.47	-3.43**	-1.95**	-0.48*	0.15	-0.17
$P_4 \times P_5$	0.25	-0.56	-0.16	-0.77*	-3.30**	-2.04**	-0.49*	-0.23	-0.36**
$P_4 \times P_6$	-0.85**	-0.90**	-0.87**	1.43**	-0.73	0.35	-0.26	-0.56**	-0.41**
$P_4 \times P_7$	-0.81**	-0.96**	-0.88**	0.98**	1.30**	1.14**	0.16	0.18	0.17
$P_5 \times P_6$	0.49*	-0.08	0.21	2.02**	1.36**	1.69**	-0.24	0.34	0.05
$P_5 \times P_7$	0.11	-0.59*	-0.24	-0.96**	2.43**	0.73**	-0.23	0.17	-0.03
$P_6 \times P_7$	-0.05	-1.11**	-0.58**	-1.35**	-3.59**	-2.47**	0.17	0.04	0.10
L.S.D. 0.05 sij	0.45	0.58	0.31	0.64	0.98	0.50	0.39	0.36	0.22
L.S.D. 0.01 sij	0.59	0.77	0.41	0.85	1.30	0.66	0.51	0.48	0.30
L.S.D0.05 (sij-sik)	0.66	0.86	0.54	0.95	1.46	0.87	0.57	0.54	0.39
L.S.D. 0.01 (sij-sik)	0.88	1.14	0.71	1.26	1.94	1.15	0.76	0.72	0.52
L.S.D. 0.05 (sij-skl)	0.62	0.80	0.19	0.89	1.36	0.31	0.54	0.51	0.14
L.S.D. 0.01 (sij-skl)	0.83	1.06	0.25	1.18	1.81	0.41	0.71	0.67	0.18

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

NS= Normal irrigation S= Stress condition C= Combined

Table (19): cont.

Crosses	Relative water content (RWC)			K^+ content m/g		
	NS	S	C	NS	S	C
$P_1 \times P_2$	-0.65	-2.03**	-1.34**	-3.26**	-2.15	-2.71**
$P_1 \times P_3$	-3.52**	-1.57*	-2.55**	-3.03**	-1.66	-2.35*
$P_1 \times P_4$	0.87	0.77	0.82*	2.96**	-1.18	0.89
$P_1 \times P_5$	1.86*	-0.66	0.60	1.07	0.83	0.95
$P_1 \times P_6$	-5.41**	-2.32**	-3.87**	-1.01	4.06*	1.52
$P_1 \times P_7$	6.91**	-1.05	2.93**	2.93**	3.23	3.08**
$P_2 \times P_3$	1.82*	-0.71	0.55	0.76	1.10	0.93
$P_2 \times P_4$	1.99**	2.79**	2.39**	0.20	2.67	1.43
$P_2 \times P_5$	-2.81**	-1.53*	-2.17**	7.80**	-0.21	3.80**
$P_2 \times P_6$	-1.18	-0.28	-0.73	3.88**	-1.18	1.35
$P_2 \times P_7$	-0.62	0.24	-0.19	6.19**	-1.04	2.57**
$P_3 \times P_4$	-2.20**	-2.90**	-2.55**	5.33**	2.33	3.83**
$P_3 \times P_5$	4.23**	0.84	2.54**	2.91**	0.14	1.53
$P_3 \times P_6$	10.91**	1.32*	6.11**	-4.92**	-0.42	-2.67**
$P_3 \times P_7$	-0.75	1.45*	0.35	-3.02**	-3.55	-3.29**
$P_4 \times P_5$	-5.10**	-1.16	-3.13**	-0.53	0.92	0.19
$P_4 \times P_6$	3.71**	-2.73**	0.49	-5.19**	-0.24	-2.71**
$P_4 \times P_7$	-6.43**	-1.49*	-3.96**	-4.29**	-3.92*	-4.11**
$P_5 \times P_6$	0.33	1.86**	1.10**	4.38**	-1.27	1.55
$P_5 \times P_7$	8.25**	4.42**	6.33**	-1.68	7.61**	2.97**
$P_6 \times P_7$	-1.36	1.65**	0.15	1.74	5.03**	3.39**
L.S.D. 0.05 sij	1.43	1.21	0.79	2.16	3.73	1.83
L.S.D. 0.01 sij	1.90	1.62	1.05	2.88	4.96	2.42
L.S.D0.05 (sij-sik)	2.12	1.80	1.39	3.22	5.54	3.19
L.S.D. 0.01 (sij-sik)	2.82	2.40	1.84	4.28	7.37	4.23
L.S.D. 0.05 (sij-skl)	1.99	1.69	0.49	3.01	5.19	1.13
L.S.D. 0.01 (sij-skl)	2.64	2.25	0.65	4.00	6.90	1.50

*** and ** significant at 0.05 and 0.01 levels of probability, respectively.**
NS= Normal irrigation S= Stress condition C= Combined

hybrids expressed significant desirable S_{ij} effects in normal, stress irrigation treatments as well as the combined analysis, respectively. The most desirable S_{ij} effects were recorded by crosses namely Sham-6 (P_2) × line-606 (P_7), ICARDA-3 (P_3) × Giza-168 (P_4) and Sham-6 (P_2) × Gemmiza-7 (P_6) for stomatal resistance (SR), by crosses Gemmiza-7 (P_6) × line-606 (P_7), Giza-168 (P_4) × Sakha-93 (P_5) and Sham-6 (P_2) × ICARDA-3 (P_3) for transpiration rate (TR), Sakha-93 (P_5) × line-606 (P_7), ICARDA-3 (P_3) × Gemmiza-7 (P_6) and Sham-6 (P_2) × Giza-168 (P_4) for relative water content (RWC) in both irrigation treatments as well as the combined analysis, Giza-168 (P_4) × Gemmiza-7 (P_6) under stress irrigation and the combined analysis and Yacora Rojo (P_1) × line-606 (P_7) under stress irrigation treatments for leaf temperature (LT) and Sakha-93 (P_5) × Line-606 (P_7) and Gemmiza-7 (P_6) × line-606 (P_7) under stress irrigation treatment as well as the combined analysis for potassium content (K^+). The mentioned combinations might be of interest in breeding programs amid at producing pure line varieties as most combinations involved at least one good combiner.

A.3. Susceptibility index (*SI*):

A.3.1. Analysis of variance, mean and heterosis

Mean squares for susceptibility index of yield and yield components are presented in (Table 20).

Results indicated that, mean squares for genotypes, parents and crosses (*SI*) were significant *SI* for all traits. **Darwish (1998), El-Borhamy (2000)** and **El-Gamal (2001)** showed significant mean squares for genotypes, parent and hybrids for *SI* of yield and yield components.

Mean performances of the seven parents of wheat for *SI* are presented in (Table 21).

Application for yield and its components based on *SI* over both irrigation treatments (normal and stress), indicated that Yacora Rojo (P_1) gave the desirable *SI* for no. of spikes/plant, 1000-kernel weight, grain yield/plant and harvest index, Gemmiza-7(P_6) for no. of kernels/spike and biological yield and line-606 (p_7) for straw and biological yields. Also, the two parents Sham-6 (P_2) and ICARDA-3 (P_3) seemed to be the best parent for harvest index.

The mean performances of *SI* for twenty-one tested hybrids are presented in (Table 21).

For no. of spikes/plant, the crosses Giza-168 (P_4) × Gemmiza-7 (P_6), Giza-168 (P_4) × Sakha-93 (P_5), Yacora Rojo (P_1) × line-606 (P_7) and ICARDA-3 (P_3) × Giza-168 (P_4) had the best susceptibility index of stress irrigation. However, the two crosses Yacora Rojo (P_1) × Gemmiza-7 (P_6) and Giza-168 (P_4) × line-606 (P_7) had low *SI* of stress irrigation.

For no. of kernels/spike, the cross Giza-168 (P_4) × Sakha-93 (P_5) followed by cross Sham-6 (P_2) × Giza-168 (P_4) had the highest tolerance for stress irrigation for this traits.

The results indicated that the crosses Sakha-93 (P_5) × line-606 (P_7), Giza-168 (P_4) × Gemmiza-7 (P_6) and Yacora Rojo (P_1) × line-606 (P_7) for 1000-kernel weight, Yacora Rojo (P_1) × Sham-6 (P_2), Yacora Rojo (P_1) × line-606 (P_7) and Giza-168 (P_4) × Sakha-93 (P_5) for straw yield, Giza-168 (P_4) × Sakha-93 (P_5)

Table (21): The genotypes mean performance for susceptibility index (SI) of yield and yield components in F_1 generation.

Genotypes	No. of spikes/plant	No. of kernels/spike	1000-kernel weight (g)	Straw yield/plant (g)
Yacora Rojo(P_1)	0.930	0.855	0.931	0.799
Sham-6 (P_2)	0.786	0.880	0.769	0.601
ICARDA-3 (P_3)	0.846	0.899	0.770	0.651
Giza-168 (P_4)	0.723	0.773	0.795	0.564
Sakha-93 (P_5)	0.807	0.809	0.758	0.595
Gemmiza-7 (P_6)	0.770	0.909	0.825	0.897
Line-606 (P_7)	0.865	0.877	0.828	0.958
$P_1 \times P_2$	0.803	0.710	0.898	1.004
$P_1 \times P_3$	0.733	0.907	0.640	0.570
$P_1 \times P_4$	0.717	0.829	0.829	0.660
$P_1 \times P_5$	0.771	0.940	0.825	0.848
$P_1 \times P_6$	0.687	0.922	0.674	0.537
$P_1 \times P_7$	0.944	0.688	0.917	1.049
$P_2 \times P_3$	0.786	0.865	0.764	0.801
$P_2 \times P_4$	0.811	0.959	0.778	0.800
$P_2 \times P_5$	0.752	0.686	0.848	0.631
$P_2 \times P_6$	0.728	0.825	0.853	0.673
$P_2 \times P_7$	0.831	0.904	0.770	0.657
$P_3 \times P_4$	0.901	0.866	0.811	0.953
$P_3 \times P_5$	0.846	0.910	0.787	0.699
$P_3 \times P_6$	0.828	0.750	0.762	0.574
$P_3 \times P_7$	0.777	0.899	0.890	0.853
$P_4 \times P_5$	0.942	0.976	0.843	0.933
$P_4 \times P_6$	0.946	0.738	0.920	0.813
$P_4 \times P_7$	0.680	0.876	0.889	0.842
$P_5 \times P_6$	0.741	0.933	0.824	0.739
$P_5 \times P_7$	0.831	0.826	0.957	0.863
$P_6 \times P_7$	0.822	0.848	0.890	0.795
Mean of parents	0.818	0.857	0.811	0.724
Mean of crosses	0.804	0.850	0.827	0.776
Mean of Genotypes	0.807	0.852	0.823	0.763
L.S.D. $_{0.05}$	0.090	0.023	0.026	0.046
L.S.D. $_{0.01}$	0.119	0.030	0.035	0.061

Table (21) cont.

Genotypes	Grain yield/plant (g)	Biological yield (g)	Harvest index
Yacora Rojo(P_1)	0.740	0.781	0.947
Sham-6 (P_2)	0.533	0.580	0.920
ICARDA-3 (P_3)	0.585	0.629	0.930
Giza-168 (P_4)	0.444	0.518	0.856
Sakha-93 (P_5)	0.494	0.562	0.879
Gemmiza-7 (P_6)	0.578	0.808	0.716
Line-606 (P_7)	0.629	0.822	0.764
$P_1 \times P_2$	0.513	0.849	0.603
$P_1 \times P_3$	0.425	0.519	0.820
$P_1 \times P_4$	0.492	0.590	0.834
$P_1 \times P_5$	0.599	0.754	0.793
$P_1 \times P_6$	0.427	0.493	0.862
$P_1 \times P_7$	0.595	0.894	0.665
$P_2 \times P_3$	0.518	0.713	0.727
$P_2 \times P_4$	0.605	0.736	0.821
$P_2 \times P_5$	0.438	0.567	0.772
$P_2 \times P_6$	0.512	0.617	0.829
$P_2 \times P_7$	0.578	0.625	0.921
$P_3 \times P_4$	0.631	0.847	0.745
$P_3 \times P_5$	0.606	0.675	0.897
$P_3 \times P_6$	0.473	0.540	0.876
$P_3 \times P_7$	0.623	0.913	0.611
$P_4 \times P_5$	0.775	0.917	0.637
$P_4 \times P_6$	0.643	0.754	0.852
$P_4 \times P_7$	0.530	0.732	0.724
$P_5 \times P_6$	0.573	0.679	0.834
$P_5 \times P_7$	0.658	0.785	0.837
$P_6 \times P_7$	0.621	0.740	0.840
Mean of parents	0.572	0.671	0.859
Mean of crosses	0.564	0.711	0.786
Mean of Genotypes	0.566	0.701	0.804
L.S.D. $_{0.05}$	0.069	0.031	0.061
L.S.D. $_{0.01}$	0.092	0.041	0.082

for grain yield, Giza-168 (P_4) × Sakha-93 (P_5) and ICARDA-3 (P_3) × line-606 (P_7) for biological yield and Sham-6 (P_2) × line-606 (P_7) for harvest index gave the best desirable susceptibility to drought resistance. Also, the cross Giza-168 (P_4) × Sakha-93 (P_5) exhibited the best desirable susceptibility to drought resistance for most yield and its components. This superiority in the previous genotypes for drought resistance may be due to high desirable for drought measurements i.e. stomatal resistance (SR), transpiration rate (TR), leaf temperature (LT), relative water content (RWC) and Potassium content (K^+).

<u>A.3.2. Heterosis:</u>

Mean squares for parent vs. crosses as an indication to average heterosis overall crosses were significant for SI in all traits except no. of spikes and grain yield/ plant (Table 20).

Heterosis expressed as the percentage deviation of F_1 mean performance from either mid-parent or better parent values for SI for yield and yield components is presented in (Table 22).

For SI of number of spikes/plant, the two crosses Giza-168 (P_4) × Sakha-93 (P_5) and Giza-168 (P_4) × Gemmiza-7 (P_6) expressed significant positive heterotic effects relative to either mid-parent or better parent.

Ten and five, twelve and eight, twelve and eight, six and two, twelve and eight and four and one parental combinations expressed significant positive heterotic effects relative to mid-parent and better-parent values for number of kernels/spike, 1000-kernel weight, straw yield/plant, grain yield/plant, biological yield/plant and harvest index, respectively. The best combinations was the cross Giza-168 (P_4) × Sakha-93 (P_5)

followed by cross Sham-6 (P_2) × Giza-168 (P_4) for straw, grain and biological yields and some of its components. This superiority in the previous genotypes for *SI* heterosis may be due to high desirable for one or more of drought measurements. The results agree with the results reported by **El-Borhamy (2000)**

A.3.3. Combining ability:

Analysis of variance for combining ability as out lined by **Griffing (1956)** method 2 model 1 is presented in (Table 23).

The variances associated with general and specific combining ability were highly significant for *SI* in all traits except GCA for number of spikes/plant. Such results indicated that additive and non-additive types of gene action were important in the inheritance of *SI*. For the exceptional traits (no. of spikes/plant), additive types of gene action seemed to be more important than non-additive gene action.

With the exception of *SI* for 1000-kernel weight, low GCA/SCA ratios of less than unity were detected for all traits indicating the predominance of non-additive gene action in the inheritance of *SI* of such traits. For the *SI* for 1000-kernel weight, high GCA/SCA ratio was obtained, revealing that the largest part of the total genetic variability associated with this of *SI* for this trait was a result of additive and additive by additive gene action. The results agree with the results reported by **El-Borhamy (2000)** and El-**Gamal (2001).**

A.3.3-1 General combining ability:

Estimates of GCA effects ($\hat{g}_i$) for individual parent for each trait of *SI* are presented in (Table 24). High positive values would be interest under all measurements of *SI* in question from the breeder point of view.

The parental variety Yacora Rojo (P_1) exhibited significant positive $\hat{g}_i$ effect of *SI* for 1000-kernel weight and straw yield/plant. It was around the average for the other traits of *SI*.

The parental variety Sham-6 (P_2) and Gemmiza-7 (P_6) had a significant negative or insignificant $\hat{g}_i$ effect of *SI* for all the studied traits.

The parental ICARDA-3 (P_3) seemed to be a good combiner of *SI* for no. of kernels/spike. On the contrary, expressed either significant negative or insignificant $\hat{g}_i$ effects of *SI* for other drought measurements.

The parental variety Giza-168 (P_4) exhibited significant positive $\hat{g}_i$ effects of *SI* for 1000-kernel weight. However, it was around the average of $\hat{g}_i$ effects of *SI* for the other traits.

The parental variety Sakha-93 (P_5) expressed significant positive $\hat{g}_i$ effects of *SI* for no. of kernels/spike. It, on the contrary, expressed either significant negative or insignificant $\hat{g}_i$ effects of *SI* for other traits.

The parental line-606 (P_7) seemed to be good combiner for *SI* in 1000-kernel weight, straw, grain and biological yields/plant. However, it was around the average of $\hat{g}_i$ effects of *SI* for the other traits. Therefore, line-606 (P_7) could be considered as an excellent parent in breeding programs aimed to release a high yielding variety under drought conditions.

Insignificant correlation coefficient values between the parental performance and its ($\hat{g}_i$) effects were detected for all studied traits (no. of spikes/plant, no. of kernels/spike, 1000-kernel weight, straw, grain and biological yields/plant and harvest index) (Table 24). This result may be due to high magnitude of non-additive gene effects in these traits.

A.3-3.2 Specific combining ability:

Specific combining ability effects of the parental combinations computed for susceptibility index for all the studied traits are presented in (Table 25).

For *SI*, four, ten, nine, nine, four, nine and seven crosses expressed significantly positive S_{ij} effects for no. of spikes/plant, no. of kernels/spike, 1000-kernel weight, straw, grain and biological yields/plant and harvest index, respectively. The most desirable S_{ij} effects for *SI* were recorded by two crosses Giza-168 (P_4) × Gemmiza-7 (P_6) and Giza-168 (P_4) × Sakha-93 (P_5) for no. of spikes/plant, two crosses Sham-6 (P_2) × Giza-168 (p_4) and Giza-168 (P_4) × Sakha-93 (P_5) for no. of kernels/spike, Giza-168 (P_4) × Gemmiza-7 (P_6) and Sakha-93 (P_5) × line-606 (P_7) for 1000-kernel weight, Yacora Rojo (P_1) × Sham-6 (P_2) and ICARDA-3 (P_3) × Giza-168 (P_4) for straw yield/plant, Giza-168 (P_4) × Sakha-93 (P_5) for grain yield/plant, Yacora Rojo (P_1) × Sham-6 (P_2) and Giza-168 (P_4) × Sakha-93 (P_5) for biological yield/plant and Sham-6 (P_2) × line-606 (P_7) for harvest index. It is interesting to note that the superiority of the previous crosses in *SI* was resulted from lower TR (Table 15).

Stress tolerant genotypes, as defined by *SI* values, need not have a high yield potential since *SI* provides a measure of

tolerance based on minimization of yield loss under stress rather than non-stress yield per se.

Genotypes identified as stress tolerant using *SI* should posses tolerance mechanisms, which may need to be incorporated into germplasm with higher yield potential, for development of high yielding stress tolerant cultivars.

B- The second study (F_2-generation):

Improving cereal crops as wheat under saline conditions is more difficult than breeding under favorable conditions. The greater degree of difficultly is due to complexity of genotype-environment interactions associated with yield and its contributing traits. An effective breeding program for improving wheat under saline such as south Sinai depends not only on amount of variability among the divers genotypes, but also on heritability for the traits under consideration. The breeder can reduce the time required for improving promising genotypes if they have significant genotypic variability.

Hybridization between widely diverse parental genotypes is one of the most important procedures for the plant breeder that enables him to isolate new genetic variability and consequently select or synthesize a new variety. **Mani** and **Rao (1975)** reported that the greatest magnitude of heterosis in wheat was obtained when the hybrid combination involved parental lines that were very diverse in origin and widely different in mean performance.

Information on the relative importance of general and specific combining ability is important in the development of efficient wheat breeding programs particularly under the stress conditions. Genetically GCA is associated with additive genes, while SCA is attributed primarily to non-additive; dominance and epistasis. It is very essential that the breeder should evaluate the potentialities and eventually combining ability have proved to be of considerable use in crop plant. It will enable to restrict the choice of fewer but efficient and productive genotypes based on their combining ability for creating a high productive basic core material, which will serve as a source material for fashioning productive cultivars required for specific needs.

The majority of findings on these aspects are based on F_1 diallel; **El-Marakby *et al*.,(1993b)** and **El-Hennawy (1996);** while similar information in F_2 generation for unselected material is reported in wheat; **Sharma *et al*., (1978).**

In the second study, parents and F_2 generation were evaluated at Ras Sudr Agricultural Experimental Station in 2004/05 growing season under saline soil with using saline irrigation water (about 5000 ppm); data were recorded on all genotypes for growth, yield and yield components.

B.1. Growth, yield and yield components:

B.1.1. Analysis of Variance and Means Performance:

Results in (Table 26) showed the analysis of variance for all the studied traits. Mean squares for genotypes, parents, F_2 crosses and parents vs. F_2 crosses were highly significant for all the studied traits except parents vs. F_2 crosses for flag leaf area.

The mean performance of the seven parental varieties and /or lines of wheat are presented in (Table 27).

Yacora Rojo (P_1) exhibited low values of plant height, flag leaf area, no. of spikes/plant, 1000-kernel weight, straw, grain and biological yields/plant.

Sham-6 (P_2) exhibited high values for harvest index and it expressed the second highest for grain yield/plant, no. of kernels/spike and 1000-kernel weight and third for biological and straw yields/plant and no. of spikes/plant. Also, it expressed medium performance for other traits.

ICARDA-3 (P_3) expressed the lowest one for harvest index, grain, straw and biological yields/plant and it was almost intermediate or low for other traits.

Giza-168 (P_4) was the top of these parents for no. of kernels/spike. Also, it gave the lowest one for 1000-kernel weight and it was intermediate for other traits.

Sakha-93 (P_5) exhibited the highest values for no. of spikes/plant, straw, grain and biological yields/plant and harvest index. Also, it gave almost intermediate for other traits.

Gemmiza-7 (P_6) performed as the first highest tested genotypes in plant height and flag leaf area. While, it was almost intermediate for other traits.

The parental line-606 (P_7) performed as the first highest tested genotypes in grain, straw and biological yields/plant and 1000-kernel weight. Also, it was almost intermediate for other traits.

B. 1. 2. F_2 hybrids performance:

For plant height, the cross Yacora Rojo (P_1) × line-606 (P_7) gave the highest value (72.12), while, the cross Yacora Rojo (P_1) × Sham-6 (P_2) recorded the lowest one.

For flag leaf area, the highest mean value was recorded by the F_2 hybrid Giza-168 (P_4) × Gemmiza-7 (P_6) (20.62) followed by cross Sham-6 (P_2) × Gemmiza-7 (P_6) (17.91). On the contrary, the cross Yacora Rojo (P_1) × ICARDA-3 (P_3), Yacora Rojo (P_1) × Gemmiza-7 (P_6), Sham-6 (P_2) × Sakha-93 (P_5) and Giza-168 (P_4) × line-606 (P_7) gave the lowest ones.

For number of spikes/plant, the F_2 crosses Sham-6 (P_2) × Gemmiza-7 (P_6), Yacora Rojo (P_1) × Giza-168 (p_4), Sham-6 (P_2) × Giza-168 (P_4) and ICARDA-3 (P_3) × line-606 (P_7) exhibited the highest mean values. On the other hand, the F_2 cross Yacora Rojo (P_1) × Gemmiza-7 (P_6) gave the lowest one.

The F_2 cross ICARDA-3 (P_3) × line-606 (P_7) exhibited the highest mean values for no. of kernels/spike, grain, straw and biological yields/plant. Also, The F_2 cross Giza-168 (P_4) × Gemmiza-7 (P_6) gave the heavier 1000-kernel weight and harvest index. On the contrary, the F_2 cross Yacora Rojo (P_1) × Sakha-93 (P_5), ICARDA-3 (P_3) × Giza-168 (P_4), ICARDA-3 (P_3) × Sakha-93(P_5), Sham-6 (P_2) × Sakha-93 (P_5), ICARDA-3 (P_3) × Sakha-93 (P_5) and ICARDA-3 (P_3) × Gemmiza-7 (P_6) recorded the lowest ones for no. of kernels/spike, 1000-kernel weight, straw, grain and biological yields/plant; and harvest index, respectively.

The F_2 cross ICARDA-3 (P_3) × line-606 (P_7), Sham-6 (P_2) × Giza-168 (P_4) and Sham-6 (P_2) × Gemmiza-7 (P_6) exhibited

Table (27): The genotypes mean performance for the studied traits from the F_2 generation.

Genotypes	Plant height (cm)	Flag leaf area (cm^2)	No. of spikes/ plant	No. of kernels/ spike	1000-kernel weight
Yacora Rojo(P_1)	50.97	10.32	3.87	43.97	43.48
Sham-6 (P_2)	56.33	17.21	6.00	48.41	44.78
ICARDA-3 (P_3)	54.04	12.50	4.56	44.15	42.85
Giza-168 (P_4)	63.10	12.21	5.04	51.57	35.42
Sakha-93 (P_5)	60.59	14.71	6.58	43.65	43.89
Gemmiza-7 (P_6)	74.31	25.09	5.75	44.21	44.49
Line-606 (P_7)	72.45	17.78	6.29	45.85	46.15
$P_1 \times P_2$	56.43	16.18	4.37	45.06	53.26
$P_1 \times P_3$	59.19	12.47	7.28	51.51	48.68
$P_1 \times P_4$	60.18	16.07	7.46	54.79	45.84
$P_1 \times P_5$	60.35	15.87	6.78	33.49	38.53
$P_1 \times P_6$	63.47	12.35	2.75	53.70	54.28
$P_1 \times P_7$	72.12	16.61	7.18	45.14	43.33
$P_2 \times P_3$	71.45	13.78	5.69	45.15	34.08
$P_2 \times P_4$	70.74	14.61	7.43	54.37	53.82
$P_2 \times P_5$	57.00	12.73	5.14	45.91	31.47
$P_2 \times P_6$	64.85	17.91	7.98	52.87	50.92
$P_2 \times P_7$	70.17	14.36	7.18	54.62	50.16
$P_3 \times P_4$	66.57	15.94	7.53	47.00	31.32
$P_3 \times P_5$	65.83	14.80	5.60	43.93	31.42
$P_3 \times P_6$	60.38	16.07	4.99	44.75	35.69
$P_3 \times P_7$	60.97	16.55	7.56	54.86	54.49
$P_4 \times P_5$	64.34	17.55	5.08	44.32	45.01
$P_4 \times P_6$	58.95	20.62	4.18	52.22	57.13
$P_4 \times P_7$	64.87	12.87	6.18	43.37	34.45
$P_5 \times P_6$	62.54	16.10	6.35	42.91	34.82
$P_5 \times P_7$	58.34	16.06	6.57	45.82	35.56
$P_6 \times P_7$	59.50	15.56	3.84	54.57	52.01
Mean of parents	61.68	15.69	5.441	45.972	43.009
Mean of crosses	63.25	15.48	6.054	48.112	43.631
Mean of Genotypes	62.86	15.53	5.901	47.577	43.476
L.S.D. $_{0.05}$	1.39	1.11	0.719	1.809	1.361
L.S.D. $_{0.01}$	1.85	1.47	0.956	2.406	1.810

Table (27) cont :

Genotypes	Straw yield / plant (g)	Grain yield / plant (g)	Biological yield (g)	Harvest index
Yacora Rojo(P_1)	12.00	7.39	19.39	38.21
Sham-6 (P_2)	18.89	13.00	31.89	40.74
ICARDA-3 (P_3)	16.96	8.60	25.56	33.79
Giza-168 (P_4)	15.23	9.20	24.43	37.66
Sakha-93 (P_5)	19.75	12.60	32.35	38.97
Gemmiza-7 (P_6)	19.93	11.30	31.23	36.20
Line-606 (P_7)	21.75	13.30	35.05	37.93
$P_1 \times P_2$	16.51	10.48	26.99	38.86
$P_1 \times P_3$	29.96	18.22	48.18	37.83
$P_1 \times P_4$	30.75	18.74	49.49	37.86
$P_1 \times P_5$	19.28	8.74	28.02	31.21
$P_1 \times P_6$	14.16	8.01	22.18	36.05
$P_1 \times P_7$	25.11	14.02	39.13	35.90
$P_2 \times P_3$	15.87	8.69	24.56	35.35
$P_2 \times P_4$	34.70	21.75	56.45	38.52
$P_2 \times P_5$	15.17	7.43	22.60	32.94
$P_2 \times P_6$	34.46	21.46	55.92	38.37
$P_2 \times P_7$	30.77	19.66	50.43	39.00
$P_3 \times P_4$	20.28	11.09	31.37	35.31
$P_3 \times P_5$	13.98	7.73	21.71	35.65
$P_3 \times P_6$	18.52	7.96	26.48	30.07
$P_3 \times P_7$	34.42	22.61	57.03	39.66
$P_4 \times P_5$	15.21	10.15	25.37	40.08
$P_4 \times P_6$	18.02	12.45	30.47	40.87
$P_4 \times P_7$	19.07	9.23	28.30	32.70
$P_5 \times P_6$	21.70	9.48	31.18	30.42
$P_5 \times P_7$	19.90	10.72	30.62	34.97
$P_6 \times P_7$	16.03	10.89	26.92	40.46
Mean of parents	17.788	10.770	28.558	37.644
Mean of crosses	22.089	12.834	34.924	36.290
Mean of Genotypes	21.014	12.318	33.332	36.629
L.S.D. $_{0.05}$	2.512	1.327	3.589	2.002
L.S.D. $_{0.01}$	3.341	1.765	4.773	2.662

significant highest mean values for grain, straw and biological yields/plant. The superior of the previous F_2 cross also higher significant mean values for one or more of yield components. Therefore, these crosses are important and prospective in wheat breeding program for tolerant to salinity.

<u>Remain heterosis:</u>

Results in (Table 26) indicated that mean squares for parents vs. F_2 crosses as an indication to average remain heterosis over all crosses were of appreciable magnitude for all traits except flag leaf area. With the exception of harvest index, the F_2 hybrids means were significant higher than parent means for all the studied traits.

Heterosis expressed as the percentage deviation of F_2 mean performance from its mid-and better-parent values for all the studied traits are presented in (Table 28).

Eleven and five; ten and four, nine and eight, nine and eight, eleven and ten, nine and eight, nine and seven, eight and eight; and five and two F_2 cross expressed significant positive heterotic effects relative to mid- parent and better-parent, for plant height, flag leaf area, no. of spikes/plant, no. of kernels/spike, 1000-kernel weight, straw yield, grain yield, biological yield/plant and harvest index, respectively.

The most desirable heterotic effects were detected for two crosses Sham-6 (P_2) × ICARDA-3 (P_3) and Sham-6 (P_2) × Giza-168 (P_4) for plant height, by three F_2 cross Yacora Rojo (P_1) × Giza-168 (P_4), ICARDA-3 (P_3) × Giza-168 (P_4), and Giza-168 (P_4) × Sakha-93 (P_5) for flag leaf area, by three crosses ICARDA-3 (P_3) × Giza-168 (P_4), Yacora Rojo (P_1) ×ICARDA-3

(P_3) and Yacora Rojo (P_1) × Giza-168 (P_4) for no. of spikes/plant, by two F_2 cross Giza-168 (P_4) × Gemmiza-7 (P_6) and Yacora Rojo (P_1) × Gemmiza-7 (P_6) for 1000-kernel weight, by four F_2 cross Yacora Rojo (P_1) × Giza-168 (P_4), Sham-6 (P_2) × Giza-168 (P_4), Sham-6 (P_2) × Gemmiza-7 (P_6) and ICARDA-3 (P_3) × line-606 (P_7) for straw, grain and biological yields/plant and two F_2 cross Giza-168 (P_4) × Gemmiza-7 (P_6) and Gemmiza-7 (P_6) × line-606 (P_7) for harvest index.

Several investigators reported significant positive heterotic effects among those are **Awaad (2002)** and **Abd El-Aty** and **Katta (2007)**

B.1.2. Combining ability:

The analysis of variance for combining ability in the F_2 data under salinity condition is presented in (Table 29). General and specific combining abilities mean squares were significant for all the studied traits. Both additive and non-additive gene effects were involved in determining the performance of single cross progeny. To reveal the nature of genetic variance, which had the greater role, GCA/SCA ratio, was computed. Values exceeding the unity were detected for plant height, flag leaf area, no. of kernels/spike and 1000-kernel weight, indicating that the largest part of the total genetic variability was due to additive and additive by additive gene effects. This result completely confirms that reached for F_1 data presented in (Table 11). On the other hand, low GCA/SCA ratio which less than unity for other traits, indicating the predominance of non-additive gene action in the inheritance of these traits. These results were along the same line of **Kheiralla and El-Defrawy (1994).**

B.1.2.1 General combining ability effects ($\hat{g}_i$):

Estimates of GCA effects ($\hat{g}_i$) for individual parental line or variety in each trait are presented in Table (30).

The parental Yacora Rojo (P_1) gave significant positive $\hat{g}_i$ effects for 1000-kernel weight. On the contrary, it expressed significant negative $\hat{g}_i$ effects for the other traits. It ranked the second best combiner for 1000-kernel weight. Such results indicated that the parental variety P_1 Yacora Rojo could be considered as excellent combiner for developing high 1000-kernel weight of genotypes.

The parental variety Sakha-93 (P_5) exhibited significant positive $\hat{g}_i$ effects for no. of spikes/plant.

The parental variety Giza-168 (P_4) expressed significant positive $\hat{g}_i$ effects for plant height, no. of kernels/spike, grain yield/plant and harvest index.

The parental variety Gemmiza-7 (P_6) exhibited significant positive $\hat{g}_i$ effects for plant height, flag leaf area, number of kernels/spike and 1000-kernel weight.

The parental variety Sham-6 (P_2) expressed significant positive $\hat{g}_i$ effects for no. of spikes/plant, number of kernels/spike, 1000-kernel weight, straw, grain and biological yields/plant and harvest index.

The parental Line-606 (P_7) had significant positive $\hat{g}_i$ effects for yield and its components Table (30). Therefore, the two parents Sham-6 (P_2) and line-606 (P_7) could be considered as an excellent parent in breeding programs releasing variety with high grain, straw and biological yields/plant and some of its components under saline condition.

The parental Giza-168 (P_4), Gemmiza-7 (P_6) and line-606 (P_7) for plant height, line-606 (P_7) for flag leaf area, line-606 (P_7) for number of spikes/plant, Sham-6 (P_2) and Giza-168 (P_4) for no. of kernels/spike, Gemmiza-7 (P_6) and line-606 (P_7) for 1000-kernel weight, Sham-6 (P_2) and line-606 (P_7) for straw, grain yield, Sham-6 (P_2) and line-606 (P_7) for biological yield and Giza-168 (P_4) and line-606 (P_7) for harvest index expressed significant positive $\hat{g}_i$ effects under drought and saline conditions Therefore, these parents could be considered as an excellent parents in breeding programs releasing variety with high potentiality for these traits under both drought and salinity condition.

Significant correlation coefficient values between the parental performance and its $\hat{g}_i$ effects were obtained for plant height and flag leaf area, also high correlation coefficient values were detected for no. of kernels/spike and harvest index. This finding indicates that the intrinsic performance of parental lines gave a good index of their general combining ability effects. Therefore, selection with the tested parental population for initiating any proposed breeding program could be practiced either on mean performance or $\hat{g}_i$ effects basis with similar efficiency. Such agreement might add another proof about the preponderance of additive genetic variance in these traits, conceding with the findings reached in (Table 29). For other traits, insignificant correlation coefficient values were detected between the two variables. This disagreement revealed that

desirable hybrid characterized could be expected by crossing between varieties of low values of these traits. It could be concluded that non-additive type of gene action had great role in the expression of these traits which is agreement with the reached above in (Table 29). **Kheiralla** and **El-Defrawy (1994).** indicated the importance of additive and non-additive gene effect controlling the inheritance of most studied traits.

B.1.2.2 Specific combining ability effects:

Specific combining ability effects of the parental combinations are presented in (Table 31).

Nine, eight, ten, ten, ten, nine, six, eight and six parental combinations showed significant positive S_{ij} effects for plant height, flag leaf area, no. of spikes/plant, no. of kernels/plant, 1000-kernel weight, straw, grain and biological yields/plant and harvest index, respectively. The most desirable inter- and intra-allelic interactions were represented by crosses Yacora Rojo (P_1) × line-606 (P_7), Sham-6 (P_2) × ICARDA-3 (P_3), Sham-6 (P_2) × Giza-168 (P_4) and ICARDA-3 (P_3) × Gemmiza-7 (P_6) for plant height, by Yacora Rojo (P_1) × Sham-6 (P_2), Yacora Rojo (P_1) × Giza-168 (P_4), Yacora Rojo (P_1) × line-606 (P_7), Giza-168 (P_4) × Sakha-93 (P_5) and Giza-168 (P_4) × Gemmiza-7 (P_6) for flag leaf area, Sham-6 (P_2) × Gemmiza-7 (P_6), Yacora Rojo (P_1) × ICARDA-3 (P_3), Yacora Rojo (P_1) × Giza-168 (P_4) and ICARDA-3 (P_3) × Giza-168 (P_4) for no. of spikes/plant, Yacora Rojo (P_1) × ICARDA-3 (P_3), Yacora Rojo (P_1) × Giza-168 (P_4), Yacora Rojo (P_1) × Gemmiza-7 (P_6) and ICARDA-3 (P_3) × line-606 (P_7) for no. of kernels/spike, Sham-6 (P_2) × Giza-168 (P_4), ICARDA-3 (P_3) × line-606 (P_7), Giza-168 (P_4) × Sakha-93 (P_5)

and Giza-168 (P_4) × Gemmiza-7 (P_6) for 1000-kernel weight, Yacora Rojo (P_1) × ICARDA-3 (P_3), Yacora Rojo (P_1) × Giza-168 (P_4), Sham-6 (P_2) × Giza-168 (P_4), Sham-6 (P_2) × Gemmiza-7 (P_6) and ICARDA-3 (P_3) × line-606 (P_7) for straw, grain and biological yields/plant and ICARDA-3 (P_3) × line-606 (P_7), Giza-168 (P_4) × Sakha-93 (P_5), Giza-168 (P_4) × Gemmiza-7 (P_6) and Gemmiza-7 (P_6) × line-606 (P_7) for harvest index.

The crosses ICARDA-3 (P_3) × line-606 (p_7), Sham-6 (P_2) × Gemmiza-7 (P_6), Yacora Rojo (P_1) × ICARDA-3 (P_3), Yacora Rojo (P_1) × Giza-168 (P_4) and Sham-6 (P_2) × Giza-168 (P_4) exhibited significant positive S_{ij} effects for most traits under study (Table 31). Therefore, these crosses seemed to be the best combinations for breeding programs towards high grain yield and some of its components under saline condition.

The crosses Sham-6 (P_2) × line-606 (P_7) , ICARDA-3 (P_3) × Sakha-93 (P_5), and Giza-168 (P_4) × Sakha-93 (P_5) for plant height, Yacora Rojo (P_1) × Sham-6 (P_2), Yacora Rojo (P_1) × line-606 (P_7), ICARDA-3 (P_3) × Giza-168 (P_4) and Giza-168 (P_4) × Sakha-93 (P_5) for flag leaf area, Sham-6 (P_2) × Gemmiza-7 (P_6), Sham-6 (P_2) × line-606 (P_7) and ICARDA-3 (P_3) × Giza-168 (P_4) for no. of spikes/plant, Yacora Rojo (P_1) × Giza-168 (P_4), Yacora Rojo (P_1) × Gemmiza-7 (P_6), Sham-6 (P_2) × Gemmiza-7 (P_6) and Sakha-93 (P_5) × line-606 (p_7) for no. of kernels/spike, Giza-168 (P_4) × Gemmiza-7 (P_6) and Gemmiza-7 (P_6) × line-606 (P_7) for 1000-kernel weight, Yacora Rojo (P_1) × line-606 (P_7), Sham-6 (P_2) × Gemmiza-7 (P_6) and ICARDA-3 (P_3) × line-606 (P_7) for straw yield/plant, Sham-6 (P_2) × Gemmiza-7 (P_6) for grain yield/plant, Yacora Rojo (P_1) × line-

Table (31): Estimates of specific combining ability effects for all studied traits from the F_2 generation.

Crosses	Plant height (cm)	Flag leaf area(cm^2)	No. of spikes/plant	No. of kernels/spike	1000-kernel weight
$P_1 \times P_2$	-3.24**	2.24**	-1.42**	-3.09**	5.50**
$P_1 \times P_3$	0.73	-0.43	1.72**	5.50**	5.58**
$P_1 \times P_4$	-0.43	2.34**	1.89**	6.15**	0.84
$P_1 \times P_5$	2.21**	2.09**	1.12**	-8.98**	-2.71**
$P_1 \times P_6$	2.14**	-4.34**	-2.12**	6.14**	5.35**
$P_1 \times P_7$	9.39**	2.27**	1.25**	-2.49**	-4.32**
$P_2 \times P_3$	9.70**	-0.65	-0.56*	-3.43**	-8.18**
$P_2 \times P_4$	6.83**	-0.65	1.16**	3.15**	9.67**
$P_2 \times P_5$	-4.43**	-2.58**	-1.21**	0.86	-8.92**
$P_2 \times P_6$	0.23	-0.32	2.42**	2.74**	2.84**
$P_2 \times P_7$	4.15**	-1.51**	0.56*	4.42**	3.35**
$P_3 \times P_4$	3.87**	1.72**	1.49**	-2.07**	-8.17**
$P_3 \times P_5$	5.60**	0.53	-0.53*	1.03	-4.31**
$P_3 \times P_6$	-3.04**	-1.11**	-0.35	-3.24**	-7.74**
$P_3 \times P_7$	-3.85**	1.72**	1.17**	6.80**	12.34**
$P_4 \times P_5$	1.96**	2.45**	-1.07**	-1.22*	7.38**
$P_4 \times P_6$	-6.62**	2.60**	-1.18**	1.60**	11.81**
$P_4 \times P_7$	-2.10**	-2.78**	-0.24	-7.33**	-9.59**
$P_5 \times P_6$	-0.56	-1.97**	0.91**	-1.54**	-6.75**
$P_5 \times P_7$	-6.16**	0.35	0.08	1.29*	-4.72**
$P_6 \times P_7$	-8.19**	-3.07**	-1.87**	4.97**	4.03**
LSD5%5(sij)	0.88	0.70	0.46	1.15	0.86
LSD1%1(sij)	1.17	0.94	0.61	1.53	1.15
LSD5%5(sij-sik)	1.31	1.05	0.68	1.71	1.28
LSD1%1(sij-sik)	1.74	1.39	0.90	2.27	1.71
LSD5%5(sij-skl)	1.23	0.98	0.63	1.60	1.20
LSD1%1(sij-skl)	1.63	1.30	0.84	2.12	1.60

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

Table (31): cont.

Crosses	Straw yield/plant (g)	Grain yield/plant (g)	Biological yield (g)	Harvest index
$P_1 \times P_2$	-5.48**	-3.10**	-8.58**	0.83
$P_1 \times P_3$	10.00**	7.08**	17.08**	2.37**
$P_1 \times P_4$	10.62**	6.68**	17.30**	0.26
$P_1 \times P_5$	1.79*	-0.84	0.95	-4.45**
$P_1 \times P_6$	-5.33**	-3.06**	-8.39**	-0.21
$P_1 \times P_7$	2.73**	0.63	3.36**	-1.47*
$P_2 \times P_3$	-6.92**	-4.95**	-11.87**	-1.27
$P_2 \times P_4$	11.73**	7.19**	18.92**	-0.24
$P_2 \times P_5$	-5.15**	-4.65**	-9.80**	-3.88**
$P_2 \times P_6$	12.14**	7.89**	20.03**	0.95
$P_2 \times P_7$	5.55**	3.77**	9.32**	0.48
$P_3 \times P_4$	-0.65	-1.03*	-1.68	-0.88
$P_3 \times P_5$	-4.31**	-1.91**	-6.21**	1.40*
$P_3 \times P_6$	-1.77*	-3.17**	-4.93**	-4.78**
$P_3 \times P_7$	11.23**	9.16**	20.40**	3.70**
$P_4 \times P_5$	-3.25**	-0.41	-3.65**	3.70**
$P_4 \times P_6$	-2.44**	0.40	-2.04	3.88**
$P_4 \times P_7$	-4.29**	-5.14**	-9.43**	-5.39**
$P_5 \times P_6$	3.88**	-0.08	3.79**	-4.63**
$P_5 \times P_7$	-0.82	-1.16**	-1.98	-1.18
$P_6 \times P_7$	-6.68**	-2.48**	-9.17**	3.70**
LSD5%(sij)	1.59	0.84	2.28	1.27
LSD1%(sij)	2.12	1.12	3.03	1.69
LSD5%(sij-sik)	2.37	1.25	3.38	1.89
LSD1%(sij-sik)	3.15	1.66	4.50	2.51
LSD5%(sij-skl)	2.22	1.17	3.16	1.77
LSD1%(sij-skl)	2.95	1.56	4.21	2.35

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

606 (P_7), Sham-6 (P_2) × ICARDA-3 (P_3), Sham-6 (P_2) × Gemmiza-7 (P_6) and Sham-6 (P_2) × line-606 (P_7) for biological yield/plant and Giza-168 (P_4) × Gemmiza-7 (P_6) for harvest index expressed significant positive S_{ij} effects under drought and salinity conditions. Therefore, these crosses seemed to be the best combinations for breeding towards high potentiality for these traits under drought and saline conditions