V. SUMMARY

The first study (F_{1-} generation)

The main objective of this investigation was to determine the extent of heterosis and combining ability estimates and their interactions with two environments (non-stress and stress irrigation treatments) for some growth and yield characters, i.e. plant height, flag leaf area, number of spikes/plant, number of kernels/spike, 1000-kernel weight, straw yield/plant, grain yield/plant, biological yield and harvest index.

The five drought measurements, i.e. stomatal resistance (SR), transpiration rate (TR), leaf temperature (LT), relative water content (RWC) and Potassium content (K^+) were estimated.

Also, the susceptibility index (SI) was calculated for the two experiments (non-stress and stress irrigation) from origin data for yield and yield components before, using a generalized formula (Saulescu *et al.* 1995).

Seven parental varieties and/or lines namely Yacora Rojo (P_1), Sham-6 (P_2), ICARDA-3 (P_3), Giza-168 (P_4), Sakha-93 (P_5), Gemmiza-7 (P_6) and line-606 (P_7) representing wide rang of variability in most of the studied traits were utilized.

Crossing among the parental materials by half diallel system was initiated at 2002/03 season. In 2003/04 growing season, two experiments were conducted in the

headquarters of Desert Research Center (DRC), each experiment include the seven parents and their 21 F_1 hybrids, which were sown on 20th November, 2003 in a randomized complete block design (RCBD) with three replications. Each plot consisted of one row; three meters long with 10 cm. between rows and plants within row were 10 cm. apart allowing a total of 30 plants per plot. The dry method of planting was used in this concern. The two experiments were planted in two adjacent fields to avoid the differences in soil productivity. The first experiment was irrigated when the field capacity was 60% depletion of the available soil moisture and the second experiment was irrigated when the field capacity was 40% depletion of the available soil moisture. The other agricultural practices were carried out as usual in the conventional wheat fields. Data were recorded on ten plants chosen at random from each plot.

An ordinary analysis of variance was firstly performed for each experiment, and then a combined analysis was carried out whenever homogeneity of error variances was realized. Bartlett's test of homogeneity of variance was used.

Heterosis was computed mean squares and as the percentage deviation of F_1 mean performance from either the mid-parent or the better parent mean (BP) average values for each individual cross. General and specific combining ability estimates were obtained by employing

Griffing's (1956) diallel cross analysis designated as a model-1 method-2.

The results obtained can be summarized as follows:

A- The First study (F_1 generation):

A.1. Growth, yield and its components:

A.1.1. Analysis of variances, means and heterosis:-

1- Irrigation treatments mean squares were significant for all studied traits. The mean values of all studied traits increased significantly with non-stress compared with stress condition.

2- Highly significant genotypes mean squares were obtained for all studied traits in separate irrigation treatments as well as the combined analysis. Significant genotypes × environment interaction mean squares were detected for all studied traits.

3- 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 no. of spikes/plant.

4- 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.

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

6- 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.

7- 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.

8- 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. 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.

9- Regarding grain yield/plant, the highest desirable heterotic effects relative to better-parent were

detected for the crosses Yacora Rojo (P_1) × Gemmiza-7 (P_6), Sham-6 (P_2) × Sakha-93 (P_5), Sham-6 (P_2) × Gemmiza-7 (P_6) and ICARDA-3 (P_3) × Gemmiza-7 (P_6) in the combined data.

A.1.2. Combining ability:

1- The mean squares associated with general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the studied traits.

2- 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. Significant mean squares of interaction between specific combining ability and irrigation treatments were obtained for all the studied traits.

3- Low GCA/SCA ratio of less than unity were obtained for 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. On the other hand, high GCA/SCA ratio which exceeded the unity was detected for other cases.

4- The ratio of SCA × irrigation treatment/SCA was much higher than ratio of GCA × irrigation treatment/GCA for all traits except straw and biological yields/plant and harvest index.

5- The parental line Line-606 (P7) 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 treatment.

6- The combination Sham-6 (P_2) × Sakha-93 (P_5) expressed significant positive S_{ij} effects for yield and some of its components. Therefore, this cross seemed to be the best combinations for breeding towards high potentiality under drought conditions.

A.2. Drought measurements:

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

1- Irrigation mean squares were highly significant for all the studied traits. Except for TR and RWC, mean values of stress condition for all drought measurements were higher than those of normal irrigation.

2- Means 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 condition.

3- 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.

4- 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.

A.2.2. Combining ability:

1- The mean squares associated with (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 content (K^+) in stress irrigation. While, mean squares due to (SCA) were significant for all drought measurements under study.

2- Low GCA/SCA ratios of less than unity were obtained 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 content (K^+) in the stress conditions. On the other hand, high GCA/SCA ratio, which exceeded than the unity were obtained for other cases.

3- 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.

4- The variety ICARDA-3 (P_3) expressed significant positive $\hat{g}_i$ effects for stomatal resistance (SR), relative

water content (RWC), and potassium content (K^+) in the normal irrigation as well as the combined analysis. Also, it seemed to be the best combiner for leaf temperature (LT) in both irrigation as well as the combined analysis, 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).

5- 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 (p7), 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 (RWC) in both irrigation treatments as well as the combined analysis.

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

A.3.1. Analysis of variance, means and heterosis:

1- The mean squares; genotypes, parents and crosses of (*SI*) were significant *SI* for all traits.

2- Yacora Rojo (P_1) gave the desirable *SI* for no. of spikes/plant, 1000-kernel weight, grain yield/plant and harvest index.

3- 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.

4- The cross Giza-168 (P_4) × Sakha-93 (P_5) exhibited the best desirable susceptibility index to drought resistance for most yield and its components.

A.3.2. Combining ability:

1- The variance associated with general and specific combining ability were highly significant for *SI* in all traits except GCA for number of spikes/plant.

2- With the exception of *SI* for 1000-kernel weight low GCA/SCA ratios of less than unity were detected for all traits.

3- The parental line-606 (P_7) seemed to be good combiner for *SI* in 1000-kernel weight, straw, grain and biological yields/plant. 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.

4- 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.

B- The second study (F_2 - generation):

In 2004/05 growing season, the parents and F_2 crosses were grown under salinity conditions at Ras Sudr Agricultural Experimental Station under saline soil with using saline irrigation water (about 5000 ppm), which were sown on 24th Nov., 2004 in a randomized complete block design (RCBD) with three replications. Each plot consisted of four rows; three meters long with 10 cm. between rows and plants within row were 10 cm. apart allowing a total of 120 plants per plot. Data were recorded on all genotypes for growth, yield and yield components i.e. plant height, flag leaf area, number of spikes/plant, number of kernels/spike, 1000-kernl weight, straw yield/plant, grain yield/plant, biological yield and harvest index.

The results obtained can be summarized as follows:

B.1. Analysis of variance, means and heterosis:

1- 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.

2- 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.

3- The F_2-crosses: 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 significant highest mean values for grain, straw and biological yields/plant. The superior of the previous F_2-crosses 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.

4- The mean squares for parents vs. F_2-crosses as an indication to average remain heterosis overall 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.

5- The most desirable heterotic effects were detected by four F_2-crosses 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.

B.2. Combining ability:

1- General and specific combining ability mean squares were significant for all the studied traits.

2- High GCA/SCA ratio exceeded the unity were detected for plant height, flag leaf area, no. of kernels/spike and 1000-kernel weight.

3- The two parents Sham-6 (P_2) and line-606 (P_7) could be considered as excellent parents in breeding programs releasing variety with high grain, straw and biological

yields/plant and some of its components under saline condition.

4- 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. Therefore, these crosses seemed to be the best combinations for breeding programs towards high grain yield and some of its components under saline condition.

5- 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 and grain yields/plant, 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.

6- 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-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 Sij 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.