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## SUMMARY

The present research was carried out during the four successive seasons, i.e. 2009/10 to 2012/13 at Shandaweel Agriculture research Station, Agriculture Research Center (ARC), Egypt. The objective of this study was to (1) Study the efficiency of pedigree selection in improving grain yield in durum wheat after three cycles of selection under normal irrigation and drought stress conditions by using grain yield/plant and 100-kernel weight as selection criteria. (2) Estimate phenotypic, genotypic coefficients of variation and heritability under normal irrigation and drought stress conditions. (3) Study the effect of selection on the correlated traits. (4) Estimate drought susceptibility index (DSI) and environmental sensitivity of the selected families to drought stress.

Three cycles of pedigree selection were completed under normal irrigation and drought stress conditions. Two durum wheat populations (*T. turgidum* var *durum*) were used from F<sub>2</sub> to F<sub>5</sub>-generations.

**In 2009/2010 season (base populations):** 1500 plants for each of F<sub>2</sub> population were grown in a non replicated trail under normal irrigation and drought stress conditions. Data collected on all the guarded plants of each population. At the end of the season, forty plants from each population under each environment were selected for each selection criterion (grain yield/plant and 100-kernel weight) to be F<sub>3</sub> families in the next season.

**In 2010/2011 season (F<sub>3</sub> generation):** Eight field experiments (four experiments for each selection criterion) were conducted to evaluate F<sub>3</sub> families selected from each treatment for each population was sown under the same environment. The best 20 plant from the best 20 families were selected from each experiment and retained to be a raised as F<sub>4</sub> families in the next season.

**In 2011/2012 season (F<sub>4</sub> generation):** Eight field experiments were conducted to evaluate F<sub>4</sub> families selected under normal irrigation and drought stress conditions for each population were sown in the same treatment. The best

10 plant from the best 10 families were selected from each experiment and retained to be raised as F<sub>5</sub> families in the next season.

**In 2012/2013 season (F<sub>5</sub> generation):** Sixteen field experiments (eight experiments for each selection criterion) were conducted to evaluate F<sub>5</sub> families selected from each treatment for each population was sown in both environments. In all these generations each family were grown in a separate row 2.5 m long, 30 cm. apart and 10 cm. between plants within row in a Randomized complete block design with three replications and the selection between and within families were applied.

The studied traits were days to heading (days), days to maturity (days), number of spikes/plant, plant height (cm), biological yield/plant (g), grain yield/plant (g), harvest index (%), 100-kernel weight (g) and number of kernels/spike.

### **1- Base populations:**

**In population 1:** Under normal irrigation, the average number of spikes/plant, plant height, biological yield, grain yield/plant, harvest index, 100-kernel weight and number of kernels/spike was 12.19 spikes, 104.4 cm, 60.9 g, 19.76 g, 0.32, 4.87 g and 32.9 kernels, respectively, the phenotypic variance for these traits ranged from 0.005 for harvest index to 590.37 for biological yield/ plant. Whereas, under drought stress conditions, the averages of previous traits were 11.17 spikes, 105.4 cm, 55.0 g, 15.93 g, 0.28, 4.50 g and 30.9 kernels, respectively, the phenotypic variance for these traits ranged from 0.006 for harvest index to 595.17 for biological yield/ plant.

**In population 2:** Under normal irrigation, the average number of spikes/plant, plant height, biological yield, grain yield/plant, harvest index, 100-kernel weight and number of kernels/spike were 11.18 spikes, 101.5 cm, 65.3 g, 18.44 g, 0.33, 5.07 g and 32.7 kernels, respectively, the phenotypic variance for these traits ranged from 0.005 for harvest index to 491.89 for biological yield/ plant. Whereas, under drought stress conditions, the averages of previous traits were 11.04 spikes, 101.6 cm, 60.7 g, 14.81 g, 0.29, 4.69 g and 28.0 kernels,

respectively, the phenotypic variance for these traits ranged from 0.005 for harvest index to 541.22 for biological yield/ plant.

## **2- Selection for grain yield/plant:**

### **2-1-F<sub>3</sub> generation:**

#### **2 -1-1- Response to direct selection for grain yield/plant under normal irrigation and drought stress conditions.**

Analysis of variance revealed significant differences between F<sub>3</sub> families for all the studied traits, except days to heading of populations 1 and 2 under both environments.

The average grain yield/plant for selected families of population 1 ranged from 16.67 to 36.60 with an average of 25.80 g under normal irrigation, while under drought stress conditions, it ranged from 13.35 to 30.12 with an average of 21.34 g. On the other hand, average grain yield/plant for population 2 ranged from 15.21 to 31.08 with an average of 21.92 g under normal irrigation, while under drought stress conditions, it ranged from 15.52 to 27.36 with an average of 21.61g.

The phenotypic coefficients of variability (pcv%) were 15.58 and 19.71% under normal irrigation and drought stress conditions, respectively in population 1, while it was 17.89 and 15.53% under normal irrigation and drought stress conditions, respectively in population 2. Genotypic coefficients of variability (gcv%) in population 1 were 14.92 and 19.22% under normal and drought stress conditions, respectively, while it was 17.44 and 14.87% under normal and drought stress conditions, respectively, in population 2. Estimates of pcv and gcv indicated the presence of variability in grain yield/plant. Broad-sense heritability estimates in population 1 were 91.65 and 95.08% under normal irrigation and drought stress conditions, respectively. In population 2, it was 94.95 and 91.73% under normal irrigation and drought stress conditions, respectively.

#### **2-1-2- Effect of direct selection for grain yield/plant on the other traits under normal irrigation and drought stress conditions:**

**In population 1:** Under normal irrigation, (pcv%) and (gcv%) values ranged from 1.06 and 0.69% for days to heading to 15.58 and 14.92% for grain yield/plant, respectively. Broad sense heritability ranged from 42.86% for days to heading to 95.19% for 100-kernel weight. While under drought stress conditions, (pcv%) and (gcv%) values ranged from 1.02 and 0.49% for days to heading to 20.29 and 19.31% for biological yield/plant, respectively. Broad sense heritability ranged from 22.77% for days to heading to 95.08% for grain yield/plant.

**In population 2:** Under normal irrigation, (pcv%) values ranged from 0.88% for days to maturity to 17.89% for grain yield/plant, (gcv%) values ranged from 0.70% for days to heading to 17.44% for grain yield/plant, Broad sense heritability ranged from 62.08% for days to heading to 94.95% for grain yield/plant. While under drought stress conditions, (pcv%) and (gcv%) values ranged from 1.00 and 0.34% for days to heading to 18.92 and 18.33% for harvest index, respectively. Broad sense heritability ranged from 14.34% for days to heading to 94.03% for harvest index.

### **2-1-3- Phenotypic and genotypic correlation coefficients:**

The results for F<sub>3</sub> families for both populations under both environments showed that the Phenotypic and genotypic correlation coefficients were high between no. of spikes/plant and each of biological yield/plant and grain yield/plant, and between grain yield/plant and each of biological yield/plant and harvest index. The Phenotypic and genotypic correlations estimates were negative between biological yield/plant with harvest index, and between 100-kernel weight with no. of kernels/spike.

### **2-2- Effect of selection for grain yield after the second and third cycles.**

#### **2-2-1- Analysis of variance for the studied traits:**

The analysis of variance for the studied traits of the selected families in cycles 2 and 3 (F<sub>4</sub> and F<sub>5</sub> generation) in populations 1 and 2 under the two environments showed that there were highly significant differences among

selected families for grain yield and other correlated traits in both F<sub>4</sub> and F<sub>5</sub> generations under normal irrigation and drought stress conditions with few exceptions.

### **2-2-2- Phenotypic, genotypic coefficients of variability and heritability estimates:**

The results indicated that (pcv%) and (gcv%) for grain yield/plant were (9.40 and 9.08%) and (5.76 and 5.08%) for F<sub>5</sub> selected families under normal irrigation and drought stress conditions, respectively, in population 1. In population 2, the above values were (9.87 and 9.61%) and (12.13 and 11.94%) for F<sub>5</sub> selected families under normal irrigation and drought stress conditions, respectively.

Heritability in broad sense values for grain yield/plant under normal irrigation and drought stress for F<sub>5</sub> selected families were 93.30 and 77.59%, respectively, in population 1. While in population 2, it were 94.79 and 96.90% under normal irrigation and drought stress conditions, respectively. Heritability for the other traits ranged from 39.79% for plant height to 98.05% for 100-kernel weight under normal irrigation, and from 84.20% for days to maturity to 94.67% for number of kernels/spike under drought stress conditions in population 1. In population 2, heritability for the other traits ranged from 76.92% for harvest index to 98.69% for plant height under normal irrigation, and from 27.69% for days to heading to 97.90% for 100-kernel weight under drought stress conditions.

### **2-2-3- Means, observed gain of the evaluated families under normal irrigation:**

**Population 1:** The results show that average grain yield/plant under normal irrigation was 22.36 g and 20.88 g under drought. It is clear that family no. 248 surpassed the better parent by 27.15 and 36% under normal irrigation and drought stress conditions, respectively.

Average days to heading, days to maturity, no. of spikes/plant, plant height, biological yield, harvest index, 100 kernel weight and no. of kernels/spike for

population 1 under normal irrigation were 93 days, 141 days, 8.6 spikes, 106.0 cm, 63.3 g, 0.35, 6.37 g and 41.3 kernels, respectively, while average the above traits under drought stress were 93 days, 140 days, 8.5 spikes, 104.0 cm, 59.5 g, 0.35, 6.17 g and 40.1 kernels, respectively.

**Population 2:** The average grain yield/plant under normal irrigation was 23.01 g and 18.63 g under drought stress. It is clear that family no. 157 surpassed the better parent by 28.27% under normal irrigation and families no. 11, 90, 107, 157, 216 and 277 under drought stress conditions.

Average days to heading, days to maturity, no. of spikes/plant, plant height, biological yield, harvest index, 100 kernel weight and no. of kernels/spike for population 1 under normal irrigation were 94 days, 140 days, 9.5 spikes, 109.4 cm, 61.1 g, 0.38, 6.54 g and 37.2 kernels, respectively, while average the above traits under drought stress were 94 days, 142 days, 7.7 spikes, 103.4 cm, 52.5 g, 0.36, 6.51 g and 37.5 kernels, respectively.

#### **2-2-4- Means, observed gain of the evaluated families under drought stress:**

**Population 1:** Average grain yield/plant under normal irrigation was 22.87 g and 19.45 g under drought stress. It is clear that families no. 26, 198 and 227 highly significantly surpassed the better parent under normal irrigation and families no. 227, 318 and 457 under drought stress conditions.

Average days to heading, days to maturity, no. of spikes/plant, plant height, biological yield, harvest index, 100 kernel weight and no. of kernels/spike for population 1 under normal irrigation were 94 days, 140 days, 8.6 spikes, 108.5 cm, 59.2 g, 0.39, 6.07 g and 44.4 kernels, respectively, while average these traits under drought stress were 94 days, 143 days, 8.0 spikes, 104.9 cm, 55.1 g, 0.36, 5.89 g and 41.5 kernels, respectively.

**Population 2:** Average grain yield/plant under normal irrigation was 24.33 g and 19.57 under drought stress. It is clear that families no. 163, 551 and 213

surpassed the better parent under normal irrigation and families no. 26, 389 and 551 under drought stress conditions.

Average days to heading, days to maturity, no. of spikes/plant, plant height, biological yield, harvest index, 100 kernel weight and no. of kernels/spike for population 1 under normal irrigation were 95 days, 145 days, 9.5 spikes, 105.0 cm, 65.4 g, 0.37, 6.09 g and 42.4 kernels, respectively, while average these traits under drought stress were 95 days, 144 days, 8.5 spikes, 106.7 cm, 59.3 g, 0.33, 5.84 g and 39.9 kernels, respectively.

### **2-3-Average observed gain from selection in the three cycles:**

**In population 1:** The observed gain for grain yield/plant under normal irrigation was 8.86 and 6.18% from the bulk sample and 6.13 and 6.35% from the better parent in C<sub>1</sub> and C<sub>2</sub>, respectively. While under drought stress conditions it was 26.02 and 9.21% from the bulk sample and was 13.69 and 9.34% from the better parent in C<sub>1</sub> and C<sub>2</sub>, respectively. The observed gain for grain yield of the selected families under normal irrigation and evaluated under both environments in C<sub>3</sub> was (9.34 and 26.32%) and (9.99 and 10.24%) from bulk sample and the better parent, respectively. On the other hand, the gain was (4.57 and 7.70%) and (4.05 and 11.91%) for families selected under drought stress and evaluated under normal irrigation and drought stress conditions, respectively. These results indicated that synergistic selection was better than antagonistic selection.

**In population 2:** The observed gain for grain yield/plant under normal irrigation was 11.84 and 8.88% from the bulk sample and was 6.98 and 6.02% from the better parent in C<sub>1</sub> and C<sub>2</sub>, respectively. While it was 16.68 and 10.22% from the bulk sample and was 15.13 and 9.37% from the better parent in C<sub>1</sub> and C<sub>2</sub>, respectively. The observed gain of the selected families under normal irrigation and evaluated under both conditions in C<sub>3</sub> was (9.21 and 10.25%) and (13.11 and 12.84%) from bulk sample and the better parent, respectively. While



these gains were (9.45 and 5.19%) and (6.59 and 4.48%) for families selected under drought stress.

#### **2-4-Drought susceptibility index and sensitivity to environments:**

The results of population 1 showed that six families of the selected families under normal irrigation and five families of the selected families under drought stress have drought susceptibility index (DSI) values less than one. The results of population 2 showed that six families of the selected families under normal irrigation and six families of the selected families under drought stress have drought susceptibility index (DSI) values less than one. These families could be considered more tolerant to drought stress conditions and could be involved in wheat breeding programs for less favorable conditions.

#### **2-5- Effect of drought stress on grain yield and other studied traits:**

**In population 1:** the reduction in grain yield/plant was 19.38, 17.29, 10.46 and 13.01% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively. The reduction in no. of spikes/plant was 8.37, 12.50, 11.69 and 6.98% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively. The reduction in 100-kernel weight was 7.60, 6.75, 4.39 and 7.54% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively.

**In population 2:** the reduction in grain yield/plant was 19.69, 1.50, 12.06 and 14.95% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively. The reduction in no. of spikes/plant was 9.89, 7.50 and 10.53% in F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively. The reduction in 100-kernel weight was 7.50 and 10.70% in F<sub>2</sub> and F<sub>5</sub> generations, respectively. These results showed that the maximum loss in grain yield/plant and the related traits was in F<sub>2</sub> generation and decreased with selection.

#### **2-6- Phenotypic and genotypic correlations:**

In populations 1 and 2 with selection under normal irrigation or drought stress conditions the highest estimates for both phenotypic and genotypic correlation were showed for the followed pairs of the studied traits: (days to heading vs days to maturity), (no. of spikes/plant vs biological yield/plant), (no. of spikes/plant vs grain yield/plant) and (biological yield/plant vs grain yield/plant).

While the phenotypic and genotypic correlation were high and negative for the followed pairs of the studied traits (no. of spikes/plant vs 100-kernel weight) and (no. of kernels/spike vs 100-kernel weight).

### **3- Selection for 100-kernel weight:**

#### **3-1-F<sub>3</sub> generation:**

#### **3 -1-1- Response to selection for 100-kernel weight under normal irrigation and drought stress conditions.**

Analysis of variance revealed significant differences among F<sub>3</sub> families in all the studied traits except, days to heading under drought stress of populations 1 and 2

The average 100-kernel weight for selected families of population 1 ranged from 5.28 to 7.06 with an average of 6.08 g under normal irrigation, while under drought stress conditions, it range from 4.50 to 6.83 with an average of 5.61 g. On the other hand, average 100-kernel weight for population 2 ranged from 5.13 to 7.08 with an average of 6.17 g under normal irrigation, while under drought stress conditions, it ranged from 5.13 to 6.93 with an average of 5.89 g.

The phenotypic coefficients of variability (pcv%) were 6.03% and 8.74% under normal irrigation and drought stress conditions, respectively in population 1, while it was 5.97% and 5.61% under normal irrigation and drought stress conditions, respectively in population 2. Genotypic coefficients of variability (gcv%) in population 1 were 5.64% and 8.54% under normal and drought stress conditions, respectively, while it was 5.77 and 5.31% under normal and drought stress conditions, respectively, in population 2. Estimates of pcv and gcv indicated the presence of variability in 100-kernel weight. Heritability estimates in broad-sense in population 1 were 87.59 and 95.42% under normal irrigation and drought stress, respectively. In population 2, it was 93.37 and 89.63% under normal irrigation and drought stress, respectively.

#### **3-1-2- Effect of selection for 100-kernel weight on the other traits under normal irrigation and drought stress conditions:**

**In population 1:** Under normal irrigation, (pcv%) and (gcv%) values ranged from 1.01 and 0.60% for days to maturity to 14.31 and 13.33% for no. of spikes/plant, respectively. Broad sense heritability ranged from 35.37% for days to maturity to 88.50% for grain yield/plant. While under drought stress conditions, (pcv%) values ranged from 1.42% for days to heading to 20.49% for biological yield/plant, (gcv%) values ranged from 0.88% for days to heading to 19.93% for grain yield/plant, Broad sense heritability ranged from 38.72% for days to heading to 95.74% for grain yield/plant.

**In population 2:** Under normal irrigation, (pcv%) and (gcv%) values ranged from 0.94 and 0.77% for days to maturity to 14.64 and 14.05% for grain yield/plant, respectively. Broad sense heritability ranged from 67.50% for days to maturity to 93.37% for 100-kernel weight. While under drought stress conditions, (pcv%) and (gcv%) values ranged from 1.22 and 0.87% for days to heading to 16.93 and 16.02% for biological yield/plant, respectively. Broad sense heritability ranged from 51.75% for days to heading to 93.15% for days to maturity.

### **3-1-3- Phenotypic and genotypic correlation coefficients:**

The results for F<sub>3</sub> families for both populations under both environments showed that the Phenotypic and genotypic correlations estimates were high between no. of spikes/plant and each of biological yield/plant and grain yield/plant, and between grain yield/plant and biological yield/plant. The Phenotypic and genotypic correlations estimates were negative between biological yield/plant and harvest index, and between 100-kernel weight and no. of kernels/spike.

### **3-2-Effect of selection for 100-kernel weight after the second and third cycles.**

#### **3-2-1- Analysis of variance for the studied traits:**

The analysis of variance for the studied traits of the selected families in cycles 2 and 3 (F<sub>4</sub> and F<sub>5</sub> generations) in populations 1 and 2 under both environments showed that there were highly significant differences among the selected families

for 100-kernel weight and other related traits in both F<sub>4</sub> and F<sub>5</sub> generations under normal irrigation and drought stress conditions with few exceptions.

### **3-2-2- Phenotypic, genotypic coefficients of variability and heritability estimates:**

The results indicated that phenotypic and genotypic coefficients of variability for 100-kernel weight were (2.84 and 2.66%) and (4.69 and 4.60%) for F<sub>5</sub> selected families under normal irrigation and drought stress conditions, respectively, in population 1. While it were (4.22 and 4.05%) and (4.43 and 4.32%) for F<sub>5</sub> selected families under normal irrigation and drought stress conditions, respectively, in population 2.

Heritability in broad sense values for F<sub>5</sub> selected families in population 1 for 100-kernel weight under normal irrigation and drought stress was 88.03 and 96.31%, respectively. While it was 91.94 and 95.34%, respectively, in population 2. Broad sense heritability for the other traits in population 1 ranged from 48.21% for no. of kernels/spike to 96.75% for grain yield/plant under normal irrigation, and from 52.15% for plant height to 94.70% for grain yield/plant under drought stress conditions. In population 2, broad sense heritability for the other traits ranged from 64.29% for harvest index to 93.93% for no. of kernels/spike under normal irrigation and from 75.27% for days to heading to 97.33% for no. of kernels/spike under drought stress conditions.

### **3-2-3- Means, observed gain with evaluation under normal irrigation:**

**Population 1:** The results show that average 100-kernel weight under normal irrigation was 6.95 g and 6.70 g under drought stress. It is clear that families no. 232, 261 and 363 highly significant surpassed the better parent under normal irrigation and drought stress conditions.

Average days to heading, days to maturity, no. of spikes/plant, plant height, biological yield/plant, grain yield/plant harvest index, and no. of kernels/spike for population 1 under normal irrigation were 93 days, 142 days, 8.6 spikes, 107.6 cm,

66.2 g, 23.27 g, 0.35 and 38.9 kernels, respectively, while average the previous traits under drought stress were 94 days, 141 days, 8.1 spikes, 105.4 cm, 60.2 g, 20.66 g, 0.34 and 38.4 kernels, respectively.

**Population 2:** The results show that average 100-kernel weight under normal irrigation was 6.85 g and 6.74 g under drought stress. It is clear that family no. 182 highly significant surpassed the better parent by an average of 19.39 and 23.11%, respectively, under normal irrigation under drought stress.

Average days to heading, days to maturity, no. of spikes/plant, plant height, biological yield/plant, grain yield/plant, harvest index and no. of kernels/spike for population 1 under normal irrigation were 94 days, 139 days, 8.9 spikes, 108.1 cm, 60.1 g, 22.44 g, 0.37 and 37.1 kernels, respectively, while average the previous traits under drought stress were 94 days, 140 days, 7.4 spikes, 102.7 cm, 51.8 g, 18.10 g, 0.35 and 36.0 kernels, respectively.

#### **2-2-4- Means, observed gain with evaluation under drought stress:**

**Population 1:** The results show that average 100-kernel weight under normal irrigation was 6.53 g and 6.41 g under drought stress. It is clear that family no. 26 highly significant surpassed the better parent by an average of 20.63 and 21.03% under normal irrigation and drought stress conditions, respectively.

Average days to heading, days to maturity, no. of spikes/plant, plant height, biological yield/plant, grain yield/plant, harvest index and no. of kernels/spike for population 1 under normal irrigation were 95 days, 142 days, 9.6 spikes, 111.9 cm, 69.5 g, 25.47 g, 0.37 and 41.0 kernels, respectively, while average the previous traits under drought stress were 94 days, 145 days, 8.2 spikes, 108.3 cm, 58.7 g, 19.85 g, 0.34 and 37.7 kernels, respectively.

**Population 2:** The results show that average 100-kernel weight under normal irrigation was 6.64 g and 6.32 g under drought stress. It is clear that families no. 171, 189 and 269 highly significant surpassed the better parent under normal irrigation under drought stress conditions.

Average days to heading, days to maturity, no. of spikes/plant, plant height, biological yield/plant, grain yield/plant, harvest index and no. of kernels/spike for population 1 under normal irrigation were 96 days, 145 days, 9.7 spikes, 106.8 cm, 69.9 g, 24.81 g, 0.36 and 38.8 kernels, respectively, while average the previous traits under drought stress were 96 days, 145 days, 9.0 spikes, 107.4 cm, 64.6 g, 20.04 g, 0.31 and 35.5 kernels, respectively.

### **2-3-Average observed gain from selection in the three cycles:**

**In population 1:** The observed gain for 100-kernel weight under normal irrigation was 9.35 and 12.62% from the bulk sample and 4.11 and 9.93% from the better parent in C<sub>1</sub> and C<sub>2</sub>, respectively. While under drought stress it was 6.65 and 10.06% from the bulk sample and 8.93 and 7.97% from the better parent in C<sub>1</sub> and C<sub>2</sub>, respectively. The observed gain for 100-kernel weight of the selected families under normal irrigation and evaluated under both environments in C<sub>3</sub> was (14.85 and 15.12%) and (18.97 and 18.79%) from the bulk sample and the better parent, respectively. On the other hand, the observed gains for families selected under drought stress and evaluated under normal irrigation and drought stress conditions was (10.68 and 12.06%) and (15.17 and 14.26%) from the bulk sample and the better parent, respectively. These results indicated that synergistic selection was better than antagonistic selection.

**In population 2:** The observed gain for 100-kernel weight under normal irrigation was 10.18 and 12.38% from the bulk sample and 6.93 and 6.39% from the better parent in C<sub>1</sub> and C<sub>2</sub>, respectively. While under drought stress it was 4.80 and 6.06% from the bulk sample and 6.32 and 6.87% from the better parent in C<sub>1</sub> and C<sub>2</sub>, respectively. The observed gain of the selected families under normal irrigation and evaluated under both environments in C<sub>3</sub> was (13.98 and 13.85%) and (9.78 and 8.19%) from the bulk sample and the better parent, respectively. While these gains for families selected under drought stress was (8.32 and 9.14%) and (8.85 and 7.84%) from the bulk sample and the better parent, respectively.

#### **2-4-Drought susceptibility index and sensitivity to environments:**

The results of population 1 showed that five families of the selected families under normal irrigation and four families of the selected families under drought stress have drought susceptibility index (DSI) values less than one. The results of population 2 showed that seven families of the selected families under normal irrigation and six families of the selected families under drought stress have (DSI) values less than one. These families could be considered more tolerant to drought stress conditions and could be involved in wheat breeding programs for less favorable conditions.

#### **2-5- Effect of drought stress on grain yield and other studied traits:**

**In population 2:** the reduction in grain yield/plant was 19.38, 18.90, 3.80 and 14.70% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively. The reduction in no. of spikes/plant was 8.37, 14.00, 3.51 and 4.65% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively. The reduction in 100-kernel weight was 7.60, 7.73, 4.66 and 7.77% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively.

**In population 2:** the reduction in grain yield/plant was 19.69, 8.13, 23.27 and 10.70% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively. The reduction in no. of spikes/plant was 9.89 and 14.14% in F<sub>3</sub> and F<sub>4</sub> generations, respectively. The reduction in 100-kernel weight was 7.50, 4.54, 6.52 and 7.20% in F<sub>2</sub>, F<sub>3</sub>, F<sub>4</sub> and F<sub>5</sub> generations, respectively. These results showed that the maximum loss in grain yield/plant and the related traits was in F<sub>2</sub> generation and decreased with selection.

#### **2-6- Phenotypic and genotypic correlations:**

The highest estimates for both phenotypic and genotypic correlation in populations 1 and 2 with selection under normal irrigation or drought stress conditions were showed for the followed pairs of the studied traits: (days to heading vs days to maturity), (no. of spikes/plant vs biological yield/plant), (no. of spikes/plant vs grain yield/plant) and (biological yield/plant vs grain yield/plant). While the phenotypic and genotypic correlations were high and negative between no. of kernels/spike vs 100-kernel weight.