

CONTENTS

SUBJECT	PAGE
<i>INTRODUCTION</i>	-1-
<i>REVIEW OF LITERATURE</i>	-3-
I – Response to selection	-3-
II- Heritability	-21-
III – Drought Susceptibility index (DSI)..	-29-
<i>MATERIALS AND METHODS</i>	-34-
<i>RESULTS AND DISCUSSION</i>	-39-
I – Base populations	-39-
II- Selection traits	-43-
① Selection for number of spikes/plant	-43-
② Selection for number of kernels/spike	-63-
③ Selection for 1000-kernel weight	-83-
④ Selection for Grain yield/plant	-102-
<i>SUMMARY</i>	-122-
<i>CONCLUSION</i>	-136-
<i>REFERENCES</i>	-138-
<i>ARABIC SUMMARY</i>	10 -1

SUMMARY

The present study was carried out at El-Mattana Agric. Res Station, Agric. Res. Center, Egypt, during the three successive seasons of 2008/2009, 2009/2010 and 2010/2011.

The objectives of the present investigation were to study the response to selection in two durum wheat populations using the pedigree selection method, also to study the interrelationships among the studied traits for improving grain yield and its components.

The materials used in these studies were two wheat populations, as follows:

- 1- **Population I** : (Bani-sweaf 1 × Line 2).
- 2- **Population II**: (Sohag 3 × Line 4).

The F₃ plants were used as a base population for selection to drive F₄ and F₅ generations. Selection was based on one of the following criterion:

- 1) Number of kernels/spike.
- 2) Number of spikes/plant.
- 3) 1000-kernel weight (gm).
- 4) Grain yield/plant (gm).

In addition, the parents of each cross, and the bulk population, were used for comparison of the selected families in each generation.

The studied traits were:

A – Morpho-physiological traits

- 1- Days to heading.
- 2- Days to maturity.
- 3- Plant height (cm)

B – Grain yield and yield components.

- 1- Number of spikes/plant.
- 2- Number of kernels/spike

3-1000-kernel weight (gm).

4- Grain yield/plant (gm).

The obtained results could be summarized as follows:

1- Selection for No. of spikes/plant:

Population I:

A. Variances and means:

The results indicated significant or highly significant differences among genotypes (selected families). The average of no. of spikes/plant for the selected families under normal and drought conditions increased from 13.2 and 12.1 in F₄ generation (cycle I) to 14.9 and 12.7 in F₅ generation (cycle 2), respectively. The average of no. of spikes/plant for the bulk population was 12.0 under normal condition in the two cycles of selection and 11.0 and 11.3 under drought condition, in F₄ and F₅ generations, respectively.

Also GCV of No. of spikes/plant decreased from 18.23% in the first cycle (C₁) to 7.08% of the second cycle (C₂), also for No. of kernels/spike, 1000-kernel weigh, and grain yield/plant. For phenotypic coefficient of variability (PCV) decreased from 19.28% in the first cycle (C₁) to 8.10% of the second cycle (C₂).

B- Heritability estimates:

Estimates of heritability in broad sense after two cycles of selection were moderate or high estimates for heading date (73.82 and 77.41%), maturity date (55.06 and 56.31%), plant height (87.69 and 77.64%), no. of spikes/plant (89.36 and 76.31%), no. of kernels/plant (99.13 and 95.98%), 1000-kernel weight (99.61 and 82.29%) and grain yield/plant (80.69 and 81.59%), respectively.

C- Realized and correlated response to selection:

The results showed that direct selection for no. of spikes/plant increased it by (9.95%) from the bulk sample under normal condition in cycle 1 (F₄) of selection. The results under drought condition in cycle 2 (F₅) showed the increasing in plant height, no. of spikes/plant, no. of kernels/ spike, 1000-kernel weigh, and grain yield/plant with decrease in heading date (-1.51%) and maturity date (-0.38%) from the bulk sample.

D- Means of the selected families:

Under normal condition, n. of spike/plant for families (N. 1 and 2) were (17.1 and 17.0) compared with (12.0 and 9.3) for the bulk sample and the check cultivar, respectively. Under drought condition the direct selection for no. of spike/plant indicate that families (No. 1, 2, 8 and 18) were (13.7) when the bulk sample and check cultivar were (11.3 and 7.2), respectively.

E- Drought Susceptibility Index (DSI):

The lowest values of drought susceptibility resulted for F₅ generations was pronounced from genotype No. 10 with value of (0.24).

Population II:**A. Variances and means:**

The results revealed significant or highly significant differences among genotypes. The overall mean of the selected families for no. of spikes/plant after two cycles under normal and drought conditions decreased from 15.4 in (cycle 1) to 15.1 spikes in (cycle 2) under normal condition and from 12.6 to 11.1 under drought condition in F₄ and F₅ generations, respectively. GCV of no. of spikes/plant in the base population decreased from 11.01 to 7.07% after the two cycles of selection.

B- Heritability estimates:

The results showed that heritability estimates for no. of spikes/plant, no. of kernels/ spike, 1000-kernel weigh, and grain yield/plant were (67.71, 93.92, 92.73 and 98.14) in F₃ and (85.02, 87.28, 88.52 and 80.22%) in F₅ under normal condition, respectively, also under drought condition heritability values after two cycles of selection were (67.88, 92.81, 94.90 and 98.36%) in F₃ and (82.37, 86.46, 84.40 and 81.11%) for no. of spikes/plant, no. of kernels/ spike, 1000-kernel weigh, and grain yield/plant, respectively.

C- Realized and correlated response to selection:

Selection for no. of spikes/plant improved it by 16.50 and 78.17% from the bulk sample and the check cultivar after two cycles of selection under normal condition, respectively. Such increase was accompanied with increasing no. of kernels/spike (18.24%), 1000-kernel weight (43.67%), grain yield/plant (43.12%) and plant height (15.10%), and decreasing heading date (-1.26%) and maturity date (-1.32%) from the check cultivar.

D- Means of the selected families:

Means of the selected families after two cycles (C₂) of pedigree selection for no. of spikes/plant under normal condition, indicated that family No. 4 was higher in no. of spikes/plant (16.7) compared with bulk sample (12.0) and check cultivar (8.5). For drought condition, families No. 1, 3, 8 were higher in No. of spikes/plant (12.0), and (7.0 and 10.3) for the check cultivar and bulk sample, respectively.

E- Drought Susceptibility Index (DSI):

The results revealed that families No. 8 and 19 have the lowest drought susceptibility index less than one (0.46 and 0.60), respectively.

2. Selection for No. of kernels/spike:

Population I:

A. Variances and means:

The analysis of variance revealed highly significant differences among genotypes. The overall mean of the selected families after two cycles of pedigree selection for No. of kernels/spike in under normal condition increased from 65.9 (C_1) to 75.3 (C_2) and increased from 77.2 to 80.3 under drought condition. Pedigree selection for No. of kernels/spike reduced the genotypic coefficient of variability (GCV) after the two cycles of selection from 18.40 (C_1) to 11.44% (C_2) and from 9.14 (F_4) to 5.33% (F_5). under normal and drought conditions, respectively.

B- Heritability estimates:

After two cycles of selection the values of broad sense heritability for no. of kernels/spike were (87.98 and 80.71%), (93.26 and 94.07%) for no. of spikes/plant, (98.11 and 91.90%) for 1000-kernel weight, (95.69 and 88.00%) for grain yield/plant, (68.40 and 56.10%) for heading date, (71.64 and 74.13%) for maturity date and (85.77 and 82.65%) for plant height under normal and drought conditions, respectively.

C- Realized and correlated response to selection:

A significant increase in no. of kernels/spike by (52.11, 7.56 and 43.87%) from the mid parent, the bulk sample and the check cultivar, respectively, after two cycles of selection under normal condition, The results under drought condition of pedigree selection for No. of kernels/spike after the second cycle increased it by 71.43, 11.51 and 72.04% from the mid-parents, the bulk sample and the check cultivar, respectively.

D- Means of the selected families:

The averages of the selected families were 75.3 and 61.3 kernels/spike in the F₅ generation under normal and drought conditions, respectively. On the other hand, the averages of the bulk sample were 70.0 and 62.0 kernels/spike under normal and drought conditions, respectively. Under normal condition, 12 F₅ families were significantly higher than bulk population, under drought condition all the families exceeded significantly the check cultivar.

E- Drought Susceptibility Index (DSI):

Application of susceptibility index after two cycles of selection based on no. of kernels/spike the lowest values of drought susceptibility resulted for F₅ was pronounced from genotype No. 9 with value of (0.67).

Population II:**A. Variances and means:**

Analysis of variance showed significant or highly significant differences among genotypes for all other studied traits except heading date and maturity date under normal condition, and heading date under drought condition. After two cycles of pedigree selection for no. of kernels/spike under normal condition increased from 65.6 (C₁) to 80.5 (C₂) and increased from 57.5 to 75.5 under drought condition.

B- Heritability estimates:

For the second cycle of selection the values of broad sense heritability for no. of kernels/spike were (84.76 and 84.03%), (81.26 and 84.12%) for no. of spikes/plant, (88.84 and 89.94%) for 1000-kernel weight, (86.23 and 83.82%) for grain yield/plant, (32.22 and 41.17%) for heading date, (46.31 and 54.93%) for maturity date and (85.46 and

83.66%) for plant height under normal and drought conditions, respectively.

C- Realized and correlated response to selection:

A significant increase in number of kernels/spike was achieved by direct selection. The results under drought condition of pedigree selection for no. of kernels/spike after the second cycle increased it by 74.27, 11.60 and 64.17% from the mid-parents, the bulk sample and the check cultivar, respectively.

D- Means of the selected families:

Under normal condition, all the families were significantly higher than bulk population, and under drought condition 18 F₅ families exceeded significantly the check cultivar. Under drought condition, its worth to note that five selected families were higher in grain yield than the bulk sample and check cultivar. Family number (2) was significant higher grain yield than the bulk sample and check cultivar.

E- Drought Susceptibility Index (DSI):

The results indicated that family No. 20 have drought susceptibility index less than one (0.78) and gave the highest no. of kernels/spike under drought condition compared with normal condition.

3- Selection for 1000-kernel weight:

Population I:

A. Variances and means:

After the two cycles of selection the analysis of variance showed highly significant differences among genotypes for all other studied traits except maturity date under normal condition. The overall mean of the selected families after two cycles of pedigree selection for 1000-kernel weight under normal condition increased from 67.0 (C₁) to 68.7 gm (C₂)

and from 65.8 (C₁) to 70.1 gm (C₂) under drought condition. The bulk sample increased from 58.5 (F₄) to 58.6 gm (F₅) under normal condition and decreased from 63.3 (F₄) to 62.4 gm (F₅) under drought condition. Pedigree selection for 1000-kernel weight in under normal condition increased the genotypic coefficient of variability (GCV) from 8.06 to 9.18% and reduced it from 10.45 to 4.67 under drought condition.

B- Heritability estimates:

The values of broad sense heritability after the two cycles of selection were (71.35 and 94.22%), (91.18 and 94.82%), (95.33 and 93.05), (92.49 and 93.18%), (64.56 and 45.39%), (83.96 and 37.48%) and (48.91 and 68.70%) for 1000-kernel weight, grain yield/plant, no. of spikes/plant, no. of kernels/spike, heading date, maturity date and plant height under normal and drought conditions, respectively.

C- Realized and correlated response to selection:

Selection for heavy grain weight after two cycles of pedigree selection increased 1000 grain weight by (17.11 and 57.36%) from the bulk sample and the check cultivar under normal conditions, respectively.

The results under drought condition, the single trait selection for 1000-kernel weight showed realized response to selection accounted 12.34 and 65.72% from the bulk sample and check cultivar, respectively.

D- Mean of selected families:

The selected families means after two cycles of pedigree selection for 1000-kernel weight revealed that family No. 1 was higher than bulk sample and check cultivar and the best family of all genotypes in 1000-kernel weight with value (82.1) and (75.3 gm, 16.9 and 79.8) for grain yield/plant, no. of spikes/plant and no. of kernels/spike under normal condition, respectively. Under drought condition, pedigree selection for heavier kernel weight resulted in family No. 15 (64.0 gm) which was heavier than the bulk sample (62.4 gm) and check cultivar (42.3 gm).

E- Drought Susceptibility Index (DSI):

Data of susceptibility index after two cycles of selection based on 1000-kernel weight (Table 44) revealed that families No. (4, 6, 7, 8, 11, 15, 16, 17 and 18) had $DSI < 1$ (0.93, 0.98, 0.71, 0.98, 0.98, 0.82, 0.46, 0.31 and 0.60), respectively. The lowest values of drought susceptibility index resulted for F_5 lines were pronounced from genotype No. 16 and 17 with values of (0.46 and 0.31), respectively.

Population II.**A. Variances and means:**

After the two cycles of selection the analysis of variance showed highly significant differences among genotypes for all other studied traits except heading date and maturity date under normal and drought conditions. The overall mean of the selected families after two cycles of pedigree selection for 1000-kernel weight under normal condition increased from 70.9 (C1) to 74.8 gm (C2) and from 63.9 (C1) to 69.2 gm (C2) under drought condition. Pedigree selection for 1000-kernel weight under normal condition increased the genotypic coefficient of variability (GCV) from 6.78 to 7.62% and reduced it from 7.99 to 7.65 under drought condition.

B- Heritability estimates:

Heritability in broad sense after the two cycles of selection were (82.84 and 80.03%), (83.37 and 84.27%), (86.35 and 79.06), (84.08 and 85.35%), (49.12 and 41.07%), (19.78 and 50.64%) and (85.48 and 77.99%) for 1000-kernel weight, grain yield/plant, no. of spikes/plant, no. of kernels/spike, heading date, maturity date and plant height under normal and drought conditions, respectively.

C- Realized and correlated response to selection:

The results under drought condition, the single trait selection for 1000-kernel weight showed realized response to selection accounted 16.41 and 71.01% from the bulk sample and check cultivar, respectively. Such increase in kernel weight caused increase in grain yield/plant (27.19 and 48.38%) and no. of spikes/plant (4.50 and 49.29%) and no. of kernels/spike (5.91 and 22.03%) from the bulk and the check cultivar, respectively, and decrease in heading date by (-0.31%), maturity date (-0.12%) and plant height (-5.79%) from the bulk sample.

D- Mean of selected families:

Family No. 6 was higher than bulk sample and check cultivar and the best family of all genotypes in 1000-kernel weight with value (91.7gm) and (28.9 gm, 7.9 and 59.6) for grain yield/plant, no. of spikes/plant and no. of kernels/spike under normal condition, respectively, and decreased in heading date, maturity date and plant height compare with the bulk sample and check cultivar.

E- Drought Susceptibility Index (DSI):

Values of drought susceptibility index ranges from (0.74 to 1.19) for F₅ generation. Meanwhile nine of genotypes gave drought susceptibility index lower than one in F₅ generation.

4- Selection for grain yield/plant:**Population I:****A. Variances and means:**

The results indicated significant or highly significant differences among genotypes (selected families) under normal and drought conditions except heading date under normal condition.

The average grain yield/plant of the selected families under normal condition increased from 51.7 F₄ generation (cycle I) to 51.8 gm/plant F₅

generation (cycle 2), and decreased from 47.0 F₄ generation to 44.67 gm/plant F₅ generation under drought condition. The average grain yield/plant for the bulk populations was 52.7 and 49.0 g/plant under normal condition, and 42.9 and 41.2 gm/plant under drought condition, in F₄ and F₅ generations, respectively. the GCV of grain yield/plant decreased from (27.37 and 29.30%) to (10.64 and 14.73%) in the base population (F₃) and F₅ generation under normal and drought conditions, respectively.

B- Heritability estimates:

Estimates of heritability in broad sense after two cycles of selection under normal and drought conditions were moderate or high estimates for grain yield/ plant (81.10 and 87.35%), no. of spikes/plant (85.07 and 82.58%) and heading date (70.97 and 58.20%), under normal and drought conditions, respectively.

C- Realized and correlated response to selection:

The results showed that direct selection for grain yield/plant increased it by 5.77% from the bulk sample after two cycles of selection, under normal condition. The results under drought condition behaved similar as under normal condition. These results showed that direct selection for grain yield/plant increased it by (8.34%) from the bulk sample after two cycles of selection.

D- Mean of selected families:

Under normal condition after two cycles, 13 families were higher than the bulk sample, the best parent and the check cultivar. Family No. 1 grain yield/plant (71.1gm) and (49.0 and 35.5) for bulk sample and the check cultivar, respectively.

Under drought condition the direct selection for grain yield/plant indicated that 11 families were higher than the bulk sample, the best parent and the check cultivar. The grain yield/plant for families (No. 1 and 3) was (53.2 and 51.9gm) and (41.2 and 27.5) for bulk sample and the check cultivar, respectively.

E- Drought Susceptibility Index (DSI):

Data indicated that the nine families in the F₅ generation gave low values of drought susceptibility index (DSI < 1).

The lowest values of drought susceptibility resulted for F₅ was pronounced from genotype No. 5 and 20 with values of (0.67 and 0.69), respectively.

Population II:

A. Variances and means:

The average grain yield/plant of the selected families increased from 48.1 F₄ generation (cycle 1) to 53.5 gm/plant F₅ generation (cycle 2), and from 44.4 F₄ generation to 50.8 gm/plant F₅ generation under normal and drought conditions, respectively. The average grain yield/plant for the bulk populations was 45.8 and 52.3 g/plant under normal condition, and 41.3 and 41.8 gm/plant under drought condition, in F₄ and F₅ generations, respectively. Under drought condition, the GCV of grain yield/plant, no. of kernels/spike and 1000-kernel weight decreased from 25.85, 17.41 and 14.53% in the base population to 13.07, 13.37 and 10.14% in the second cycle (C₂), respectively.

B- Heritability estimates:

Heritability in broad sense after two cycles of selection under normal and drought conditions were moderate or high estimates for grain yield/plant (82.51 and 82.11%), no. of spikes/plant (87.42 and 81.06%), no. of kernels/spike (82.18 and 86.41%), 1000-kernel weight (86.29 and

81.40%), heading date (61.12 and 44.09%), maturity date (61.22 and 31.30%) and plant height (67.40 and 76.62%), respectively.

C- Realized and correlated response to selection:

Under normal condition the results indicated that direct selection for grain yield/plant increased it by (0.39%) from the bulk sample after two cycles of selection. Such increase was accompanied with increase in No. of spikes/plant (1.87%), No. of kernels/spike (6.62%), 1000-kernel weight (7.72%) and heading date (1.69%) and decrease in plant height (-5.37%) and maturity date (-3.00%).

The results under drought condition behaved similar as under normal condition. These results showed that direct selection for grain yield/plant increased it by (6.59%) from the bulk sample after two cycles of selection. Such increase was accompanied with increase in no. of spikes/plant (9.70%), no. of kernels/spike (8.31%) and 1000-kernel weight (7.39%), heading date (0.55%) and maturity date (1.00%) and decrease in plant height (-2.46%).

D- Mean of selected families:

Under normal condition after two cycles of selection, 7 families were higher than the bulk sample, the best parent and the check cultivar. Family No. 13 grain yield/plant (65.4gm) and (52.3 and 31.0) for bulk sample and the best parent, respectively.

Under drought condition the direct selection for grain yield/plant after two cycles of selection indicated that 13 families were higher than the bulk sample, the best parent and the check cultivar. The grain yield/plant for family (No. 3) was (53.9 gm) and (41.8 and 27.6) for bulk sample and the best parent, respectively.

E- Drought Susceptibility Index (DSI):

Data of susceptibility index after two cycles of selection based on grain yield/plant showed that families No. (3, 6, 8, 9, 12, 14, 15, 18, and 20) gave low values of drought susceptibility index ($DSI < 1$), with values (0.83, 0.85, 0.55, 0.35, 0.85, 0.40, 0.82, 0.61 and 0.81), respectively.

The lowest values of drought susceptibility resulted for F_5 was pronounced from the families No. 9 and 14 have drought susceptibility index less than one (0.35 and 0.40), respectively.

CONCLUSION

Yield and its Components

The Results under normal conditions in population I indicted that family no 1 the best for no of spikes/plant with value 17.1, for no of kernels/spike with value 77.6, for 1000-kw (gm) with value 67.1 and family no 1 the best for grain yield/plant with value 56.1. While in population II the family no 4 the best under normal conditions for no of spikes/plant with value 16.7 meanwhile the family no 1 was the best for no of kernels/spike with value 78.3, and family no 6 for 1000-kw (gm) with value 71.7 and the best for grain yield/plant was family no 13 with value 50.4.

Meanwhile results under drought conditions indicated that in population I family no 1, 2 and 8 the best for no of spikes/plant with value 13.7, family no 4 was the best for no of kernels/spike with value 54.7, family no 1 was the best for 1000-kw (gm) with value 52.3 and the for grain yield/plant with value 42.1. Also in population II the family no 1, 3 and 8 the best for no of spikes/plant with value 12.0, family no 1 the best for no of kernels/spike with value 55.7, family no 6 the best for 1000-kw (gm) with value 58.8 and family no 3 the best under drought conditions for grain yield/plant with value 40.8.

Therefore, these genotypes could be considered promising genotypes in breeding wheat program.

Drought susceptibility index (DSI):

The Drought Susceptibility Index “DSI” was used to estimate the relative stress injury (drought) because it is accounted as variation in yield potential and stress intensity. Higher values indicated higher degree of susceptibility and vice versa (**Fischer and Maurer, 1978**).

It is worthy to mention here that drought susceptibility index provides a measure of tolerance based on minimization of yield loss

under stress rather than non-stress yield per se. Therefore, the stress tolerant genotypes as defined by S values do not need to have a high yield potential. These genotypes should contain resistance mechanisms, which may need to be incorporated into germplasm with higher yield potential for development of high yielding stress tolerant cultivars.

Low stress susceptibility ($DSI < 1$) is synonymous with higher stress tolerance. Results under drought conditions indicated that the values of drought susceptibility index “DSI” in population I for family no 9 the best for no of kernels/spike with value 0.67, family no 17 the best for 1000-kw (gm) with value 0.31 and family no 5 the best for grain yield/plant with value 0.67. While family no 10 the best family in population I under drought conditions because it gave a values less than one for, no of spikes/plant with value 0.24, no of kernels/spike with value 0.81 and for grain yield/plant with value 0.70.

Meanwhile results in population II under drought conditions showed that the drought susceptibility index “DSI” in family no 8 the best for no of spikes/plant with value 0.46 , family no 20 the best for no of kernels/spike with value 0.78 , family no 1 the best for 1000-kw (gm) with value 0.74. While family no 9 the best family in Population II under drought conditions because it gave a values less than one for; no of spikes/plant with value 0.91, 1000-kw (gm) with value 0.99 and for grain yield/plant with value 0.35.

Results of drought susceptibility index investigation indicated that, the genotypes have relatively high grain yield under drought stress and low drought susceptibility index (tolerance for drought), could be used as source of drought tolerance / or factor contributing to general adaptation.