Proceed, Seventh Pl. Breed. Conf.
May 4-5, 2011 (Alexandria)

Egypt. J. Plant Breed (15) 2: 65-79
Special Issue (2011)

GENETIC ANALYSIS OF YIELD AND ITS COMPONENTS UNDER NORMAL AND DROUGHT CONDITIONS IN SOME BARLEY CROSSES

Amer, Kh. A., A. A. Eid and M. M. A. El-Sayed
Barley Dept., Field Crops Res. Institute, ARC, Egypt

ABSTRACT

This investigation was carried out at Sakha Agricultural Research station during the two seasons 2008/2009 and 2009/2010 using six diverse barley varieties and/or lines (Hordeum vulgare L.). All possible parental combinations without reciprocals were made among the six genotypes, giving 15 crosses. The six parental genotypes and 15 F_1's were planted in two experiments. The first experiment, was irrigated with the recommended treatment i.e three irrigations (favorable conditions). The second one was irrigated with planting irrigation only. Plant height, spike length, number of spikes/ plant, number of grains/ spike, 100–grain weight and grain yield, /plant were studied. Results indicated that water stress treatments decreased the means of all studied traits for parents and their hybrids. Statistical analysis revealed highly significant effects of genotypes for most traits, providing evidence for presence of large amount of genetic variability. Based on GCA estimates, it could be concluded that the best combiners were Sico for all traits except for number of spikes/ plant and 100-grain weight; Giza 2000 for 100-grain weight, Giza 121 for spike length, 100-grain weight and grain yield/plant and Line-1 for 100-grain weight all conditions and Giza 124 for plant height and number of spikes/plant at stress and combined. Based on the estimates of SCA, it could be summarized that the best hybrids were Sico× Giza 2000, Giza 2000× Line-2 and Giza 124 × Line-2 for plant height, Giza 121× Line-1 and Giza 124× Line-2 for spike length, Sico × Giza 124, Giza 2000 × Line-2 and Giza 124 × Line-1 for number of spikes/ plant, Sico × Giza 121 and Giza 124 × Line-2 for number of graind/ spike, Sico × Giza 121 and Sico x Line-1 for 100- grain weight and most crosses for grain yield/ plant at all conditions. Drought susceptibility index (DSI) used to estimate relative stress injury because it accounted for variation in yield potential and stress intensity. This index could be estimated based on many traits. Which included ***Giza 2000, Giza 124, Line-2, Giza 2000 × Giza 121, Giza 124 × Line-1*** *and* ***Line-1 × Line-2*** *were tolerant for most traits, indicating the importance of this parent in this regard. In addition, Sico and Line 1,* ***Sico × Line-1*** *and* ***Sico × Giza 124*** *were susceptible genotypes for most traits. Significant or highly significant and positive correlations were obtained among most traits and grain yield/plant under all conditions.*

INTRODUCTION

Barley (*Hordeum Vulgare* L.) has a great adaptation potential in many regions of the world. It has a good tolerance to biotic stresses such as salinity, drought, frost and heat. It is considered one of the most important crops ranking the fourth in the world cereal crops production. Its economic importance is due to its usage it for animal feeding, brewing malts and human food in some areas. In Egypt, barley is mainly used as animal feed (grain and straw) and sometimes for bread making by bedouins.

In Egypt barley is a minor winter cereal crops grown mainly in rainfed areas where limited water supply is a feature such as in the Northwest Coastal region and North of Sinai, also it is grown over wide range of soil variability and under many diverse climatic conditions compared with many other grain crops. So, it can be grown in irrigated saline lands and poor soil conditions. It has also been grown in the newly reclaimed lands as well as the old land.

Therefore, the main objective of this study included the induction of new promising barley genotypes having high yield potentially and more tolerant to drought stress, this was approached through the following:-

1. Identification of superior parents and their crosses from a 6 × 6 diallel cross of barley parental genotypes grown under water stress and normal irrigation regime.
2. Estimation of combining ability effects and the mode of gene action in the inheritance of grain yield and some related agronomic traits.
3. Estimation the susceptibility index (SI) for yield and some related agronomic traits.

MATERIALS AND METHODS

The present investigation was carried out at the experimental farm of Sakha Agricultural Research Station ,Kafr El-Sheikh, Egypt, during the two successive seasons 2008/2009 and 2009/2010. Six parental genotypes of barley were used, the names and pedigrees of which are presented in Table (1).

Table (1): Names and pedigrees of parental barley genotypes.

No	**Genotypes**	**Pedigree**
1	**Sico (P_1)**	Local variety
2	**Giza 2000 (P_2)**	Local variety
3	**Giza 121 (P_3)**	Local variety
4	**Giza 124 (P_4)**	Local variety
5	**Line-1 (P_5)**	Mr 25 - 84 / Att /3/ Mari / Aths // Bc
6	**Line-2 (P_6)**	Alanda//Lignee527 / Arar

In 2008/2009 season, the parental genotypes were sown at various planting dates in order to overcome the differences in flowering time. All possible parental combinations excluding reciprocals were made among the six genotypes. In 2009/ 2010 season, seeds of the parents and their 15 F_1 hybrids were planted in two experiments. The first experiment was given planting irrigation only (drought stress conditions, S). The second was irrigated three times after planting irrigation (normal conditions, N). Each experiment was designated in a randomized complete block design with three replicates. Each parent and F_1 was represented by two rows per replicate. Each row was 1.5 m long, and spaces between rows were 30 cm with 15 cm between plants. All the recommended agronomic practices for barley production were applied at the proper time. Ten guarded plants were randomly taken from each entry to collect data on plant height, spike length, number of spikes/plant, number of grains/ spike, 100-grain weight and Grain yield/ plant.

An ordinary analysis of variance for each experiment and the combined analysis across the two experiments (stress and normal irrigation) were performed according to Snedecor and Cochran (1967), whenever homogeneity of error was detected. Combining ability analysis was performed according to Griffing (1956) model 1 method 2.

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

DSI = (1 - Y_d / Y_p) / D.

Where:

Y_d = Performance of a genotype under drought stress,

Y_p= Performance of a genotype under normal irrigation,

D= drought stress intensity = 1 - (mean Y_d of all genotypes/ mean Y_p of all genotypes).

Estimates of the simple phenotypic correlation (r) coefficients among all traits for the entries means were calculated according to Kearsey and Pooni (1996).

RESULTS AND DISCUSSION

Analysis of variances:

Mean squares of different barley genotypes for all studied characters in each enviroment and their combined data are presented in Table (2).

Statistical analysis revealed highly significant effects of irrigation treatments on all studied characters, indicating that the two irrigation regimes behaived differently for these characters. In addition, mean squares due to genotypes were highly significant for all traits, providing evidence for presence of large amount of genetic variability, which considered adequate for further biometrical assessment. Significant or highly significant differences for all traits were found among the parents under the two conditions and their combined. Meanwhile, highly significant differences of crosses mean squares were detected for all characters, reflecting the diversity of the parents for these studied characters and that these diversity could be transmitted to the progenies. However, mean squares of parents vs. crosses showed highly significant differences for all traits, except for plant height under normal, number of grains/ spike at normal and combiend and 100-grain weight under normal condition, where the differences were not significant, indicating the presence of hybrid vigor for the studied barley genotypes. Mean squares of genotypes × environment interactions were significant or highly significant for all traits except for spike length, revealing that the genotypes responded differently to water regime for these traits and reflecting the possibility of selecting the most tolerant genotypes. Mean squares of parents × environment were not sigificant for all traits, except plant height. Crosses × environments mean squares were significant or highly significant for all studied traits, except for spike length and number of spikes/ plant, revealing the overall differences between these hybrids. A comparison of the parents versus F_1 crosses × environment revealed highly significant differences except for spike length and number of spikes/plant.

The results indicated that mean squares of general combining ability (GCA) and specific combining ability (SCA) were highly significant for all the studied traits of barley genotypes under the two environments and their combined.

The significance of general and specific combining ability indicate the presence of both additive and non additive types of gene effects in the genetic system controlling these traits. The mean squares of interaction between environment and each of general and specific combining ability were highly significant for all studied traits. The GCA values were higher than those of SCA for all traits under the study, except those of grain yield/plant under the two conditions. These results suggest predominant role of additive type of gene action for these traits and the potential for obtaining further improvements of these traits by using pedigree selection program. Similar results were reported by Abd El-Aty and El-borhamy (2007).

Table (2): Mean square of different barley genotypes for all studied traits in each environment and their combined analysis.

S.O.V	df.		Plant height (cm)			Spike length (cm)			Number of spikes/plant		
	Single	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Environments	-	1	-	-	4367.2**	-	-	10.48**	-	-	47.42**
Replication	2	-	5.19	22.53**	-	0.11	0.22	-	3.05**	2.29*	-
Rep. with Env.	-	4	-	-	13.87**	-	-	0.17**	-	-	2.67**
Genotypes	20	20	164.51**	67.24**	170.99**	2.24**	1.65**	3.67**	4.14**	4.11**	7.30**
Parents	5	5	301.29**	77.04**	243.1**	3.48**	2.87**	6.24**	3.66**	3.32**	5.77**
Crosses	14	14	126.18**	50.1**	142.86**	1.4**	0.79**	1.93**	4.51**	4.56**	8.14**
P vs. C	1	1	17.17	258.18**	204.26**	7.67**	7.54**	15.2**	1.49**	1.78**	3.26**
Genotypes × Env.	-	20	-	-	60.75**	-	-	0.21	-	-	0.95*
Parents × Env.	-	5	-	-	135.2**	-	-	0.11	-	-	1.2
Crosses × Env.	-	14	-	-	33.42**	-	-	0.26	-	-	0.92
P vs. C × Env.	-	1	-	-	71.1**	-	-	0.01	-	-	0.01
GCA	5	-	78.31**	30.09**	46.77**	2.02**	1.30**	1.59**	1.54**	2.04**	1.73**
SCA	15	-	47.01**	19.85**	22.41**	0.36**	0.30**	0.30**	1.33**	1.15**	1.05**
GCA × Env.	-	5	-	-	61.63**	-	-	1.73**	-	-	1.85**
SCA × Env.	-	15	-	-	44.45**	-	-	0.36**	-	-	1.43**
Error	40	80	13.11	9.58	11.35	0.26	0.21	0.24	0.56	0.72	0.64
Error term (e/r)			4.37	3.19	3.78	0.09	0.07	0.08	0.19	0.24	0.21
GCA/SCA			0.22	0.20	0.29	0.87	0.69	0.87	0.15	0.25	0.23

* and ** Significant at 0.05 and 0.01 levels of probability, respectively

Table (2) cont.

S.O.V	df.		Number of grains/spike			100-grain weight (g)			Grain yield/plant (g)		
	Single	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Environments	-	1	-	-	248.36**	-	-	5.28**	-	-	549.5**
Replication	2	-	5.33	19.81	-	0.01	0.02	-	1.64	0.94	-
Rep. with Env.	-	4	-	-	12.57	-	-	0.02	-	-	1.29
Genotypes	20	20	55.54**	49.74**	89.38**	0.46**	0.73**	0.96**	50.01**	39.10**	84.12**
Parents	5	5	57.8**	57.66*	102.78**	0.94**	0.88**	1.78**	29.0**	5.28	29.2**
Crosses	14	14	58.64**	45.46**	87.93**	0.32**	0.69**	0.72**	29.85**	32.84**	57.87**
P vs. C	1	1	0.77	70.0**	42.72	0.01	0.51**	0.19**	437.2**	295.86**	726.18**
Genotypes × Env.	-	20	-	-	15.9*	-	-	0.23**	-	-	4.98*
Parents × Env.	-	5	-	-	12.91	-	-	0.04	-	-	5.06
Crosses × Env.	-	14	-	-	16.17*	-	-	0.28**	-	-	4.82*
P vs. C × Env.	-	1	-	-	28.05**	-	-	0.33**	-	-	6.88**
GCA	5	-	37.09**	45.47**	39.85**	0.58**	0.72**	0.63**	16.22**	7.32**	10.42**
SCA	15	-	12.32**	6.95**	6.58**	0.19**	0.08**	0.09**	16.49**	14.94**	15.04**
GCA × Env.	-	5	-	-	42.71**	-	-	0.67**	-	-	13.12**
SCA × Env.	-	15	-	-	12.69**	-	-	0.18**	-	-	16.39**
Error	40	80	8.13	10.08	9.10	0.03	0.03	0.03	2.27	3.26	2.77
Error term (Ms e/r)			2.71	3.36	3.33	0.01	0.01	0.01	0.76	1.09	0.92
GCA/SCA			0.45	1.47	1.30	0.39	1.20	0.98	0.12	0.06	0.08

* and ** Significant at 0.05 and 0.01 levels of probability, respectively

Mean performance

The mean performance of the six parents and their F_1 crosses under normal and stress conditions as well as combined data are presented in Table (3). The mean performance for all genotypes were generally decreased under stress conditions and deficiency of soil moisture. Similar results were obtained by Mohammed (2001), Bayoumi (2004), Moursi (2003), Mohamed (2004), Farhat (2005), El-Sayed (2007) and El-Shawy (2008). Regarding plant height, Sico and Giza-121 were the tallest parents under normal and combined, while Sico × Giza 2000 and Sico × Giza 124 showed the tallest cross among crosses under both conditions and combined. For spike length, the result clearly showed that the parents Sico and Giza-121 had the tallest spikes among the parents at both conditions, excepectealy, their F_1 had the tatest spikes among the rest of F_1 studied under both conditions and their combined. For number of spikes/plant, Line-1 and Line-2 gave the highest numbers among the parents, while Giza 2000× Line-2 and Giza 124× Line-1 gave the highest cross under both conditions and their combined. For number of grains/spike, Sico ranked first among the parents under both conditions and their combined, while the cross Sico × Giza 121 gave the highest number of grains under both conditions and combined. Concerning 100-grain weight, results showed that Giza 2000 and Giza 121 had the heaviest grains among the parents under both conditions and their combined, meanwhile, Sico × Giza 121 and Giza 121 × Line-2 under normal and Giza 2000× Giza 121 under stress gave the heaviest grains among the crosses. For grain yield/plant, Sico and Line-1 were the best of parents under both conditions and their combined. Also Sico × Giza 121, Sico × Giza 124 and Giza 2000 × Giza 121 gave the highest values for grain yield/plant under the two conditions and their combined.

General combing ability effects:

Estimates of general combining ability effects for parents under normal and water stress conditions are presented in Table 4. Significantly positive GCA values concluded that Sico (P_1) could be considered as a good general combiners for plant height, spike length, number of grains/spike and grain yield/plant at all conditions, Giza 2000 (P_2) for 100-grain weight at all conditions, Giza 121 (P_3) for spike length, 100-grain weight, grain yield/plant at all conditions and plant height at normal and combined conditions, Giza 124 (P_4) for plant height and number of spikes/plant at stress and combined conditions, Line-1 (P_5) for 100-grain weight at both conditions and Line-2 (P_6) for spike length under normal and number of spikes/plant under normal and combined conditions. Similar results were obtained by Ahmed (1990), Zeng *et al* (2001), Moustafa (2002), Singh *et al* (2002), Sharma *et al* (2003), Mahmoud (2006), El-Sayed (2007), Katta (2009) and Amer (2010).

Specific combining ability effects:

Estimates specific combining ability effects of all barley F_1 hybrids are given in Table 5.

The best crosses for plant height were Sico × Giza 2000, Giza 2000 × Line-2, Giza 121 × Line-1, Giza 124 × Line-2 (at all conditions), Giza 2000 × Line-1 (at stress and combined), Giza 2000 × Giza 124 (at normal) and Sico × Giza 124 at water stress condition.

While, the best crosses for spike length were Giza 121 × Line-1, Giza 124 × Line-2 (at all conditions), Sico × Giza 124 (at normal and combined), Sico × Line-1, Giza 2000 × Line-1, Giza 124 × Line-1 (at stress and combined) and Sico × Giza 121 (at water stress condition); for number of spikes/plant were Sico × Giza 124, Giza 2000 × Line-2, Giza 124 × Line-1 (at all conditions), Sico × Giza 2000, Giza 124 × Line-2 (at normal) and Giza 2000 x Giza 121 (at stress and combined conditions); for number of grains/spike were Sico x Giza 121 (at all conditions), Sico × Giza 124, Giza 2000 × Giza 121 (at normal and combined), Giza 124 × Line-2 (at all conditions), Sico × Giza 2000 and Giza 121 × Giza 124 (at water stress condition); for 100-grain weight were Sico × Giza 121, Sico × Line-1 (at all conditions), Giza 121 × Line-2 (at normal and combined), Giza 121 × Giza 124, Giza 124 × Line-2 (at stress and combined), Giza 2000 × Giza 121 and Line-1 × Line-2 (at water stress condition); and for grain yield/ plant were all crosses except for Sico × Line-1, Sico × Line-2, Giza 2000 × Giza 124, Giza 121 × Giza 124 and Line-1 × Line-2 at all conditions. It is worthy to note that most of superior F_1 crosses with grain yield and most of yield components traits included one of their parents of high GCA effects for the same traits. These results are in general agreement with those reported by Ahmed (1990), Bhatnagar and Sharma (1997), Sharma *et al* (2003), Mahmoud (2006), El-Sayed (2007), Katta et al (2009), Amer (2010) and Eid (2010).

Table (3): Means of parents and their F1 crosses for all the studied traits in the two environment and their combined data.

Genotypes	Plant height (cm)			Spike length (cm)			Number of spikes/plant		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sico	105.33	82.00	93.67	10.00	9.23	9.62	11.67	9.33	10.50
Giza 2000	83.33	79.50	81.42	8.33	8.00	8.17	10.33	10.00	10.17
Giza 121	106.00	82.67	94.33	9.33	9.00	9.17	12.00	10.07	11.03
Giza 124	93.33	89.00	91.17	8.17	7.67	7.92	11.33	11.27	11.30
Line-1	97.67	76.40	87.03	7.00	6.53	6.77	13.00	11.40	12.20
Line-2	83.67	74.87	79.27	9.33	8.30	8.82	13.33	12.10	12.72
Sico × Giza2000	110.67	94.77	102.72	9.67	9.44	9.56	12.00	9.83	10.92
Sico × Giza 121	98.33	88.50	93.42	10.33	10.00	10.17	11.33	10.60	10.97
Sico × Giza 124	101.00	92.33	96.67	10.67	9.24	9.96	12.33	11.27	11.80
Sico ×Line-1	87.67	82.13	84.90	9.67	9.13	9.40	11.00	10.67	10.83
Sico × Line-2	95.00	83.67	89.33	10.00	9.20	9.60	9.00	7.83	8.42
Giza 2000 × Giza 121	92.67	84.33	88.50	9.33	8.80	9.07	12.67	11.80	12.23
Giza 2000 × Giza 124	101.00	79.33	90.17	8.50	8.23	8.37	13.00	11.67	12.33
Giza 2000 × Line-1	96.00	84.50	90.25	8.67	8.42	8.54	12.33	10.17	11.25
Giza 2000 × Line-2	93.67	85.97	89.82	9.67	8.67	9.17	13.67	13.17	13.42
Giza 121 × Giza 124	91.67	83.13	87.40	8.80	8.67	8.73	12.33	11.53	11.93
Giza 121 × Line-1	101.00	84.83	92.92	9.83	9.33	9.58	13.10	11.17	12.13
Giza 121 × Line-2	92.67	84.47	88.57	9.67	8.50	9.08	12.83	11.00	11.92
Giza 124 × Line-1	96.00	83.00	89.50	8.67	8.38	8.53	13.33	12.70	13.02
Giza 124 × Line-2	100.00	86.67	93.33	10.00	9.00	9.50	13.67	11.07	12.37
Line-1 × Line-2	83.33	80.67	82.00	8.67	8.17	8.42	12.00	11.20	11.60

Table (3) cont.

Genotypes	Number of grains/spike			100-grain weight (g)			Grain yield/plant (g)		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sico	76.00	73.20	74.60	5.22	5.21	5.21	32.37	25.70	29.04
Giza 2000	68.00	64.00	66.00	5.75	5.65	5.70	23.83	21.80	22.82
Giza 121	68.00	67.60	67.80	5.77	5.33	5.55	26.30	23.23	24.77
Giza 124	64.00	60.00	62.00	5.43	5.18	5.31	25.23	22.77	24.00
Line-1	70.67	65.20	67.93	5.70	5.32	5.51	27.63	23.15	25.39
Line-2	74.00	64.87	69.43	4.31	4.08	4.19	24.50	22.59	23.54
Sico × Giza 2000	74.67	72.00	73.33	5.27	5.19	5.23	33.63	29.17	31.40
Sico × Giza 121	78.00	75.93	76.97	5.83	5.39	5.61	36.23	32.96	34.60
Sico × Giza 124	78.67	71.47	75.07	5.37	4.63	5.00	37.30	31.27	34.28
Sico × Line-1	71.33	69.03	70.18	5.72	5.41	5.57	31.37	24.72	28.04
Sico × Line-2	73.33	71.00	72.17	4.99	4.02	4.50	30.37	24.30	27.33
Giza 2000 × Giza 121	74.00	67.33	70.67	5.57	5.50	5.54	34.80	32.66	33.73
Giza 2000 × Giza 124	68.00	64.80	66.40	5.31	4.91	5.11	28.50	24.27	26.38
Giza 2000 × Line-1	66.00	64.00	65.00	5.71	5.43	5.57	34.20	27.88	31.04
Giza 2000 × Line-2	67.33	66.17	66.75	5.41	4.35	4.88	30.17	27.26	28.71
Giza 121 × Giza 124	70.00	64.00	67.00	5.57	5.40	5.48	32.13	25.83	28.98
Giza 121 × Line-1	70.00	67.33	68.67	5.13	4.81	4.97	33.63	29.47	31.55
Giza 121 × Line-2	68.00	63.00	65.50	5.88	4.33	5.10	30.94	28.87	29.90
Giza 124 × Line-1	68.00	65.70	66.85	5.46	5.12	5.29	33.60	31.40	32.50
Giza 124 × Line-2	72.00	68.00	70.00	4.91	4.61	4.76	35.10	28.06	31.58
Line-1 × Line-2	64.67	63.73	64.20	4.82	4.73	4.78	25.17	21.93	23.55

Table (4) Estimates of general combining ability effects for all parents or all studied traits in each environment and their combined data.

Parent	Plant height (cm)			Spike length (cm)			Number of spikes/plant		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sico (P_1)	4.17**	2.23**	3.20**	0.74**	0.60**	0.67**	-0.83**	-0.94**	-0.89**
Giza 2000 (P_2)	-1.17	0.04	-0.56	-0.31**	-0.14	-0.22**	-0.13	-0.01	-0.07
Giza 121(P_3)	2.29*	0.38	1.33*	0.24*	0.34**	0.29**	0.13	-0.06	0.03
Giza 124 (P_4)	0.79	1.86**	1.33*	-0.22*	-0.21*	-0.22**	0.25	0.51**	0.38**
Line-1 (P_5)	-1.33	-2.46**	-1.89**	-0.68**	-0.52**	-0.60**	0.25	0.29	0.27**
Line-2 (P_6)	-4.75**	-2.05**	-3.40**	0.24*	-0.07	0.08	0.33*	0.22	0.28**
LSD $_{0.05}$	1.36	1.17	1.22	0.19	0.17	0.12	0.28	0.32	0.20
LSD $_{0.01}$	1.82	1.56	1.63	0.26	0.23	0.16	0.38	0.43	0.27

* and ** indicate significance at 0.05 and 0.01 levels of probability, respectively

Table (4): cont.

Parent	Number of grains/spike			100-grain weight (g)			Grain yield/plant (g)		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sico (P_1)	4.17**	4.52**	4.34**	-0.08	0.02	-0.03	2.32**	0.92**	1.62**
Giza 2000 (P_2)	-1.08*	-0.92	-1.00*	0.17**	0.23**	0.20**	-0.93**	-0.19	-0.56*
Giza 121(P_3)	-0.25	0.81	0.28	0.29**	0.16**	0.23**	0.53*	1.22**	0.88**
Giza 124 (P_4)	-1.67**	-1.55*	-1.61**	-0.08	0.02	-0.03	0.28	-0.01	0.13
Line-1 (P_5)	-1.33*	-1.52*	-1.43**	0.17**	0.15**	0.16**	-0.35	-0.59	-0.47*
Line-2 (P_6)	0.17	-1.34*	-0.59	-0.46**	-0.59**	-0.52**	-1.85**	-1.36**	-1.60**
LSD $_{0.05}$	1.07	1.20	0.86	0.12	0.06	0.04	0.57	0.68	0.46
LSD $_{0.01}$	1.44	1.60	1.14	0.16	0.08	0.05	0.76	0.91	0.62

*** and ** indicate significance at 0.05 and 0.01 levels of probability, respectively**

Table (5) Estimates of Specific combining ability effects for F_1 crosses for all studied traits in each environment and their combined data.

Crosses	Plant height (cm)			Spike length (cm)			Number of spikes/plant		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sico × Giza 2000	11.95**	8.56**	10.26**	-0.07	0.31	0.12	0.77*	-0.18	0.30
Sico × Giza 121	-3.84*	1.96	-0.94	0.06	0.39*	0.22	-0.15	0.64	0.25
Sico × Giza 124	0.33	4.31**	2.32	0.85**	0.18	0.51**	0.73*	0.74*	0.73**
Sico × Line-1	-10.9**	-1.58	-6.23**	0.31	0.39*	0.35*	-0.94**	0.69	-0.13
Sico × Line-2	-0.13	-0.45	-0.29	-0.27	0.01	-0.14	-2.69**	-2.4**	-2.6**
Giza 2000 × Giza 121	-4.17**	-0.02	-2.10	0.10	-0.07	0.01	0.48	0.91*	0.69**
Giza 2000 × Giza 124	5.66**	-6.5**	-0.42	-0.11	-0.09	-0.10	0.69*	0.21	0.45
Giza 2000 × Line-1	2.79	2.98*	2.88*	0.35	0.42*	0.39**	0.02	-1.1**	-0.53*
Giza 2000 × Line-2	3.87*	4.04**	3.95**	0.43	0.21	0.32*	1.27**	2.00**	1.63**
Giza 121 × Giza 124	-7.13**	-3.05*	-5.09**	-0.65**	0.01	-0.33*	-0.23	0.13	-0.05
Giza 121 × Line-1	4.33**	2.97*	3.65*	1.14**	0.84**	0.99**	0.44	-0.02	0.21
Giza 121 × Line-2	-0.59	2.20	0.81	0.23	-0.44*	-0.11	0.35	-0.12	0.12
Giza 124 × Line-1	0.83	-0.35	0.24	0.27	0.46*	0.36*	0.64*	0.95*	0.79**
Giza 124 × Line-2	8.24**	2.92*	5.58**	0.68**	0.61**	0.65**	0.89**	-0.62	0.14
Line-1 × Line-2	-6.30**	1.23	-2.53	-0.19	0.09	-0.05	-0.77*	-0.27	-0.52*
LSD $_{0.05}$	3.09	2.64	2.76	0.44	0.39	0.27	0.64	0.72	0.46
LSD $_{0.01}$	4.14	3.54	3.69	0.58	0.53	0.37	0.86	0.97	0.62

*** and ** indicate significance at 0.05 and 0.01 levels of probability, respectively**

Table (5) : cont.

Crosses	Number of grains/spike			100-grain weight (g)			Grain yield/plant (g)		
	Normal	Stress	Comb.	Normal	Stress	Comb.	Normal	Stress	Comb.
Sico × Giza 2000	-1.37	3.59**	1.11	-0.18	-0.04	-0.11**	1.45*	1.83*	1.64**
Sico × Giza 121	3.80**	3.13*	3.46**	0.36**	0.24**	0.30**	2.66**	4.18**	3.42**
Sico × Giza 124	5.88**	1.02	3.45**	-0.26	-0.39**	-0.33**	3.58**	3.71**	3.65**
Sico × Line-1	-1.79	-1.45	-1.62	0.49**	0.25**	0.37**	-1.13	-2.24**	-1.69**
Sico × Line-2	-1.29	0.34	-0.47	0.11	-0.41**	-0.15**	-0.96	-1.91*	-1.44**
Giza 2000 × Giza 121	5.05**	-0.03	2.51*	-0.22	0.19**	-0.02	4.24**	5.00**	4.62**
Giza 2000 × Giza 124	0.46	-0.21	0.13	-0.51**	-0.34**	-0.42**	-1.51*	-2.14**	-1.82**
Giza 2000 × Line-1	-1.87	-1.04	-1.45	0.24	0.07	0.15**	4.45**	2.04*	3.25**
Giza 2000 × Line-2	-2.04	0.95	-0.54	0.20	-0.26**	-0.03	1.95**	2.18**	2.06**
Giza 121 × Giza 124	-4.37**	3.26*	-0.55	0.03	0.24**	0.13**	0.70	-2.02*	-0.66
Giza 121 × Line-1	1.30	0.57	0.93	-0.89**	-0.49**	-0.69**	2.66**	2.19**	2.43**
Giza 121 × Line-2	-2.20	-3.95**	-3.07**	0.74**	-0.22**	0.26**	1.49*	2.36**	1.93**
Giza 124 × Line-1	0.71	1.29	1.00	-0.18	-0.05	-0.12**	2.91**	5.36**	4.14**
Giza 124 × Line-2	3.21*	3.41*	3.31**	0.11	0.19**	0.15**	5.74**	2.79**	4.27**
Line-1 × Line-2	-4.45**	-0.89	-2.67**	-0.14	0.19**	0.03	-3.30**	-2.76**	-3.03**
LSD $_{0.05}$	2.44	2.71	1.94	0.27	0.14	0.08	1.29	1.54	1.05
LSD $_{0.01}$	3.26	3.63	2.60	0.36	0.19	0.11	1.72	2.06	1.41

*** and ** indicate significance at 0.05 and 0.01 levels of probability, respectively**

4.5- Drought susceptibility index (SI):

A drought susceptibility index (SI), which provides a measure of stress resistance based on minimization of yield loss under stress as compared to optimum conditions, rather than on yield level under stress, has been used to characterize the relative drought tolerance of wheat genotypes (Fisher and Maurer, 1978). This index was used to estimate the relative stress loss because it accounted for variation in yield potential and stress intensity. This index could be estimated based on many traits. Lower stress susceptibility index than unity (SI<1) is synonymous to high stress tolerance, while high stress susceptibility index (SI >1) mean higher stress sensitivity.

Means performance of drought susceptibility index (SI) of all barley genotypes calculated for all studied traits are presented in Table (6).

Data indicated that for plant height three parents (Giza 2000, Giza 124 and Line-2) possessed DSI less than one, revealing that these parents were more resistance to water stress. For hybrids, all cresses were more resistant to stress conditions except for Sico × Giza 2000, Giza 2000 × Giza 124, Giza 121 × Line-1, Giza 124 × Line-1 and Giza 124 × Line-2.

Regarding (DSI) for spike length parent Giza 2000, Giza 121 and Giza 124 in addition to all crosses except for Sico × Giza 124, Sico × Line-2, Giza 2000 × Line-2, Giza 121 × Line-2 and Giza 124 × Line-2 showed the highest resistance to stress condition. Three parent (Giza 2000, Giza 124 and Line-2) and seven crosses showed the highest resistance to stress condition expressed by number of spikes/plant. As for number of grains/ spike, two parents (Sico and Giza 121) and eight crosses showed the highest resistance to stress environments. For 100-grain weight, all parent and crosses showed the resistance to water stress conditions except for parent Giza 121 and the crosses Sico × Giza 121, Sico × Giza 124, Sico × Line-2, Giza 2000 × Giza 124, Giza 2000 × Line-2 and Giza 121 × Line-2. Regarding grain yield/plant, four parent and ten crosses showed low susceptibility (SI < 1) to stress conditions.

Table (6): Susceptibility index for barley parents and their F1 crosses based on all studied traits.

Genotypes	Plant height (cm)	Spike length (cm)	Number of spikes/ plant	Number of grains/ spike	100-grain weight (g)	Grain yield/ plant (g)
Sico	1.80	1.23	1.99	0.92	0.03	1.52
Giza 2000	0.37	0.64	0.32	1.47	0.25	0.63
Giza 121	1.79	0.57	1.60	0.15	1.03	0.86
Giza 124	0.38	0.98	0.06	1.56	0.64	0.72
Line-1	1.77	1.07	1.22	1.94	0.90	1.20
Line-2	0.85	1.77	0.92	3.09	0.72	0.58
Sico × Giza 2000	1.17	0.37	1.79	-0.93	0.21	0.98
Sico × Giza 121	0.81	0.52	0.64	0.66	1.02	0.67
Sico × Giza 124	0.70	2.14	0.86	2.29	1.85	1.19
Sico × Line-1	0.51	0.88	1.27	1.02	0.72	1.56
Sico x Line-2	0.97	1.28	1.29	0.80	2.62	1.47
Giza 2000 × Giza 121	0.73	0.92	0.68	2.26	0.06	0.45
Giza 2000 × Giza 124	1.74	0.50	1.02	1.18	1.02	1.09
Giza 2000 × Line-1	0.97	0.46	1.74	0.76	0.65	1.36
Giza 2000 × Line-2	0.67	1.66	0.36	0.43	2.63	0.71
Giza 121 × Giza 124	0.76	0.25	0.64	2.35	0.40	1.45
Giza 121 × Line-1	1.30	0.82	1.47	0.95	0.84	0.91
Giza 121 × Line-2	0.72	1.93	1.42	1.84	3.56	0.49
Giza 124 × Line-1	1.10	0.52	0.47	0.85	0.85	0.48
Giza 124 × Line-2	1.08	1.60	1.89	1.39	0.84	1.48
Line-1 × Line-2	0.26	0.92	0.66	0.36	0.24	0.95

Correlation studies:

Correlation coefficient is important in plant breeding where it measures the degree of association between two or more characters. The correlation coefficients among the studied characters of barley genotype under the two conditions and their combined are shown in Table 7.

Significant or highly significant positive correlations were observed between plant height and each of spike length, number of grains/ spike and grain yield/ plant under all conditions, and number of spike/ plant and 100-grain weight under combined. Highly significant and positive correlation coefficients were observed between spike length and each of number of spikes/plant and grain yield/ plant under the two conditions and their combined. Highly significant positive correlations were found between number of spikes/ plant and grain yield/ plant under combined condition. Highly significant and positive correlation was detected between number of grains/ spike and grain yield/plant under all conditions and their combined. Meanwhile, the correlation coefficient between 100-grain weight and grain yield/plant was highly significant and positive under combined condition. Similar results were obtained by **Kashif and Khaliq (2004), Saleem et al. (2006) and Muhammad et al. (2010).**

Table (7): Simple correlation coefficients among the studied traits under normal, water stress and combined conditions.

Traits	Env.	Plant height	spike length (cm)	No. of spikes /plant	No. of grains/ spike	100-grain weight(g)	Grain yield / plant (g)
Plant height(cm)	Normal		0.302*	0.125	0.300**	0.129	0.422**
	Stress		0.444**	-0.136	0.409**	0.058	0.507**
	Comb.		0.458**	0.287**	0.429**	0.329**	0.605**
spike length (cm)	Normal			-0.107	0.626**	-0.168	0.489**
	Stress			-0.177	0.727**	-0.034	0.476**
	Comb.			0.009	0.700**	0.039	0.552**
No. of spikes / plant	Normal				-0.112	-0.092	0.165
	Stress				-0.244	-0.420**	0.176
	Comb.				-0.039	0.113	0.330**
No. of grains/ Spike	Normal					-0.138	0.397**
	Stress					0.117	0.370**
	Comb.					0.113	0.456**
100-Grain/ weight(g)	Normal						0.194
	Stress						0.081
	Comb.						0.294**

*** and ** indicate significance at the 0.05 and 0.01 level of probability, respectively.**

REFERENCES

Abd El-Aty, M. S. M. and H. S. El-Borhamy (2007). Estimates of combining ability and susceptibility index in wheat diallel crosses under stress and normal irrigation treatments. Egypt. J. Plant Breed. 11: 651-667.

Ahmed, I. A. (1990). Combining ability analysis over environments in diallel crosses of barley (*Hordeum vulgare L.*). Zagazig J. Agric. Res. 17: 1109-1114.

Amer, Kh. A. (2010). Inheritance of drought tolerance in some barley genotypes. Third field crops conf. 27-29, September 2010. Under press.

Bayoumi, T. Y. (2004). Diallel cross analysis for bread wheat under stress and normal irrigation treatments. Zagazig J. Agric. Res. 31: 435-455.

Bhatnagar, V. K. and S. N. Sharma (1997). Diallel analysis for grain yield and harvest index in barley under diverse environments. Rachis. publ. 16: 22-27.

Eid, A. A. (2010). The genetic behavior for salinity tolerance in some barley genotypes. Third field crops conf. 27-29, September 2010. Under press.

El-Seidy, E. H. and A. B. Khattab (2000). Heterosis and combining ability in barley under drought conditions at different growth stages. Proc.9th., Agron. Conf. Minufiya, 1-2 Sept. 2000:167-182.

El-Shawy, E. E. A. (2008). Genetic analysis of some important traits of six-rowed barley in normal and saline affected fields. M. Sc. Thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ., Egypt.

Farhat, **W.Z.E. (2005).** Genetical studies on drought tolerance in bread wheat (*Triticum aestivum* L). M.sc. Thesis, Tanta Uni., Egypt.

Fisher, R.A. and **R. Maurer** (1978). Drought resistance in spring wheat cultivars I. Grain yield responses. Aust. J. Agric. Res., 29:897-912.

Griffing, J.B. (1956). Concept of general and specific combining ability in relation to diallel crossing system. Aust. J. Biol. Sci. 9: 463-493.

Kashif, M. and I. Khaliq (2004). Heritability, correlation and path coefficient analysis for some metric traits in wheat. Int. J. Agri. Bio. 6: 138-142.

Katta *et al.* (2009). Studies on tolerance of some hulless barley crosses to drought. 6th International Plant Bred. Conf., Ismalia, Egypt, 3-5 May 2009. 867:885.

Kearsey, M. and H. Ponni (1996). The genetical analysis of quantitative traits. Chapman and Hall. London. U.K.

Mahmoud, Badeaa A. M. (2006). Genetic evaluation of some barley traits in crosses under saline and non-saline conditions. M. Sc. thesis, Fac. Agric., Kafr El-Sheikh, Tanta Univ., Egypt.

Mohamed, I A. E. I. (2001). Breeding studies on drought tolerance in bread wheat (*Triticum aestivum* L). M. Sc. thesis, Zagazig Univ., Egypt.

Mohamed, Magda E. A. (2004). Genetical analysis and evaluation of drought tolerance trait under different conditions in wheat (*Triticum aestivum* L). Ph. D. thesis, Tanta Univ., Egypt.

Moursi, A.M. (2003). Performance of grain yield for some wheat genotypes under stress by chemical desiccation. Ph. D. thesis, Zagazig Univ., Egypt.

Moustafa, Kh. A. (2002). Diallel cross analysis of some quantitative traits in barley. Zagazig J. Agric. Res., 29: 1069-1079.

Muhammad, I. Kh., H. Makhdoom, M. Zulkiffal, A. Nadeem and S. Waseem (2010). Correlation and path analysis for yield and yield contributing characters in wheat (*Triticum aestivum* L.). African J. of Plant Sci. 4: 464-466.

Sharma, Y., S. N. Sharma., P. Joshi and R. S. Sain (2003). Combining ability in the F_1 and F_2 generations of a diallel cross in six rowed barley (*Hordeum vulgare L.*). Acta Agron. Hungaricae., 51: 281-288.

Singh, H. C., S. K. Singh and S. K. Singh (2002). Combining ability and heterosis in six rowed barley. Progressive Agric., 2: 54-56. (Cited after CAB Abs. 2003/11-2004/07).

Snedecor, G. and **W. G. Cochran (1967).** Statistical Methods.6thed., lowa state Univ. press, Ames, lowa, USA.

Saleem, U., I. Khaliq, T. Mahmood and M. Rafique (2006). Phenotypic and genotypic correlation coefficients between yield and yield components in wheat. J. Agric. Res. 44: 1-6.

Zeng, Y., Chen Liang Zeng and L. Z. Chen (2001). Combining ability and heterosis in forage barley. Indian J. Genet. and Plant Breed. 61: 71-73.

التحليل الوراثى للمحصول ومكوناته تحت الظروف الطبيعية والجفاف فى بعض هجن الشعير

خيرى عبدالعزيز عامر، علاء على عيد، محمد منصور عبدالعاطى السيد

قسم بحوث الشعير- معهد بحوث المحاصيل الحقلية- مركز البحوث الزراعية- مصر

أجريت هذه الدراسة بمزرعة محطة البحوث الزراعية بسخا خلال موسمي ٢٠٠٩/٢٠٠٨ و ٢٠١٠/٢٠٠٩، باستخدام ستة تراكيب وراثية من الشعير المتباعدة وراثيا. و كانت هذه التراكيب هي: سايكو، جيزة ٢٠٠٠، جيزة ١٢١، جيزة ١٢٤، سلالة ١ وسلالة ٢. وقد أجريت كل التهجينات الممكنة بين الآباء مع استبعاد الهجن العكسية. وزرعت الآباء والجيل الأول الهجين في تجربتين منفصلتين، أعطيت الأولى ثلاث ريات بعد رية الزراعة (ظروف عادية) ، بينما أعطيت الثانية رية الزراعة فقط (ظروف جفاف). تم دراسة مجموعة من الصفات الهامة وهى: طول النبات، طول السنبلة، عدد السنابل/نبات، عدد الحبوب فى السنبلة، وزن المائة حبة ومحصول الحبوب للنبات. أوضحت النتائج أن الإجهاد الرطوبى أدى إلى خفض في متوسطات التراكيب الوراثية المختلفة بالنسبة لكل الصفات تحت الدراسة لكل من الآباء والهجن. من تحليل التباين نجد أن تأثير معاملتي الري عالي المعنوية لكل الصفات، مما يبين اختلاف كل من معاملتي الري بالنسبة لهذه الصفات. وكانت الاختلافات بين التراكيب الوراثية عالية المعنوية لمعظم الصفات مما يوضح وجود قدر كافى من التباين الوراثي بين تلك التراكيب الوراثية. التقديرات الخاصة بالقدرة العامة على الائتلاف أظهرت أن الصنف سايكو يعتبر أب مشارك جيد لكل الصفات ماعدا عدد السنابل للنبات ووزن المائة حبة، الصنف جيزة ٢٠٠٠ لصفة وزن المائة حبة، الصنف جيزة ١٢١ لصفات طول السنبلة، وزن المائة حبة ومحصول

الحبوب للنبات، سلالة- ١ لوزن المائة حبة تحت كلا المعاملتين و الصنف جيزة ١٢٤ لطول النبات وعـدد الـسنابل للنبات تحت ظروف الإجهاد. أظهرت نتائج القدرة الخاصة على التآلف أن الهجن سايكو x جيزة ٢٠٠٠، جيزة ٢٠٠٠ × سلالة- ١و جيزة ١٢٤ × سلالة- ١ كانت أفضل الهجن للطول النبات، جيزة ١٢١ × سلالة- ١، جيـزة ١٢٤ × سلالة- ٢ بالنسبة لطول السنبلة، جيزة ٢٠٠٠ × سلالة- ٢ و جيزة ١٢٤ × سلالة- ٢ لعدد السنابل/ النبـات، جيـزة ١٢١ × سلالة ١ و لعدد الحبوب فى السنبلة ووزن المائة حبة، سايكو × جيزة ١٢١ و جيـزة ١٢٤ × سـلالة- ٢ بالنسبة لعدد الحبوب فى السنبلة، سايكو × جيزة ١٢١ و سايكو × سلالة- ١ بالنسبة لوزن المائة حبة وكـذلك معظـم الهجن تحت الدراسة بالنسبة لمحصول الحبوب للنبات وذلك تحت كلا المعاملتين. أظهر التحليل الخاص بدليل الحساسية للجفاف أن الاصناف جيزة ٢٠٠٠، جيزة ١٢٤ و سلالة- ٢ والهجن وجيزة ٢٠٠٠ × جيزة ١٢١، جيـزة ١٢٤ × سلالة- ١ و وسلالة- ١ × سلالة- ٢ كانت مقاومة للجفاف على أساس معظم الصفات. على الجانب الآخر، فإن سايكو و سلالة- ١ والهجينين سايكو × سلالة- ١ و سايكو × جيزة ١٢٤ كانت من أكثر التراكيب الوراثية تحـت الدراسـة حساسية للجفاف وذلك على أساس معظم الصفات المدروسة. لوحظ وجود ارتباط معنوى أو عالى المعنوية بين معظم الصفات المدروسة ومحصول الحبوب للنبات تحت كلا المعاملتين.