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

Egypt. J. Plant Breed (15) 2: 25-37
Special Issue (2011)

GENETICAL STUDIES ON TOLERANCE OF SOME BARLEY CROSSES TO DROUGHT

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ABSTRACT

The present experiment was carried out at Sakha Agriculture Research Station during the three successive seasons 2007/08, 2008/09 and 2009/010. To determine the type of gene effects by using the six populations (P_1, P_2, F_1, F_2, BC_1 and BC_2) of five barley crosses were raised; cross 1 (Sico × Giza124); cross 2 (Sico × Line-2); cross 3 (Giza 2000 × Line-2), cross 4 (Giza 121 × Line-1) and cross 5 (Giza 124 × Line-2). Six populations of the five crosses were grown under normal irrigation and water stress conditions. Grain yield and its components and some growth attributes were studied. Generation means were significantly different for all studied traits in all crosses. Results, in general indicated that the presence of non-allelic interaction for all studied traits in all crosses under study. Also, the relative importance of additive-dominance effects varied with traits and crosses under the two conditions. Among the epistatic components, the dominance × dominance was greater in magnitudes than additive × additive and additive × dominance in most studied traits. Positive heterotic effects relative to the mid parent and better parent were found for most of the studied traits under both conditions. Heritability estimates in broad sense were relatively high to moderate for all studied traits in all crosses under normal irrigation and water stress conditions. While, heritability estimates in narrow sense were low to moderate for all studied traits in all crosses under normal irrigation and water stress conditions. The expected genetic advance as percent of F_2 ranged from low to high in all crosses for all traits in both conditions. These results indicated the possibility of practicing selection in early generations and obtain high yielding genotypes. Generally, the most promising crosses were the two crosses 1 and 2, were found to be higher in magnitude which had high genetic advance associated with high heritability values and would be interested in breeding programs for improving the most studied traits in barley.

Key words: Barley, Crosses, Gene effects, Heritability, Genetic advance, Heterosis.

INTRODUCTION

Barley (***Hordeum vulgare* L.**) is as ancient as the origin of agriculture itself. The antiquity of barley is documented to periods of 5000 to 7000 **B.C** or earlier. It is said that barley is the most widely adapted of all grains. It is more tolerant to drought, saline and alkaline soils than other cereals. Barley is the world's fourth most important crop, the fourth ranking cereal in the USA and the second ranking cereal in Canada and some other countries.

In Egypt, barley is one of the most important cereal crops mainly used for animal feed (grain and straw) and bread making by Bedouins. Also, it is one of the most important 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 grow over wide range of soil variability and under many diverse climatic conditions compared with many other grain crops.

Therefore, The main objective of this study included the induction of new promising barley genotypes that are able to produce high yield and are more tolerant to water stress condition.

MATERIALS AND METHODS

The present study was carried out at experimental farm of Sakha Agricultural Research Station, North region of Nile Delta, Agricultural Research Center (ARC), Egypt during the three successive seasons 2007/2008 to 2009/2010.The experimental material comprised six parental varieties/lines of barley to obtain the following five crosses; cross 1 (Sico × Giza124); cross 2 (Sico × Line-2); cross 3 (Giza 2000 × Line-2), cross 4 (Giza 121 × Line-1) and cross 5 (Giza 124 × Line-2). Pedigree of parental genotypes is given in Table (1).

In 2007/2008 season, the parental genotypes were crossed to obtain F_1 grains. In 2008/2009 season, the hybrid grains of the five crosses were sown to give F_1 plants, at the same time, these plants were selfed to produce F_2 and some of F_1 plants of each cross were backcrossed to each of the two parents to produce the backcrosses (BC_1 and BC_2). In 2009/2010 season, the six populations P_1, P_2, F_1, F_2, BC_1 and BC_2 of the five crosses were sown in a randomized complete block design with three replications under normal (three irrigations after planting irrigation) and water stress condition (planting irrigation only). Each experimental unit consisted of two rows for each genotype of the two parents and F1 and three rows for each of the two backcrosses and 10 rows for the F_2 population. Row was 1.5m in length, 30 cm. apart and 15 cm. between grains within row. Data were recorded on 30, 30, 300 and 75 random guarded plants for both parents, F_1, F_2 and backcrosses of each cross. The studied traits were; plant height, spike length, number of spikes per plant, number of grains per spike, 100-grain weight and grain yield per plant. Various biometrical parameters were calculated for different traits only if the F_2 genetic variance was significant. Heterosis was expressed as the percentage of the deviation of F_1 hybrid over mid and better parent values. Inbreeding depression was calculated as the difference between the F_1 and F_2 means expressed as a percentage of the F_1 mean.

Table (1): name, pedigree and origin of the six barley genotypes.

No.	Genotype	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

Statistical and genetic analysis:

The population means and the variances were used to calculate Scaling test as outlined by Mather (1949) and Hayman and Mather (1955) to determine the presence of non-allelic gene interactions. Means of the six populations in each cross were used to estimate the six parameters of gene effects, using Gamble's procedure (1962).The standard error of a, d, aa, ad and dd was obtained by taking the square root of their respective variances. T–test values were calculated by dividing the effects of a, d, aa, ad and dd on their respective standard errors. Heritability estimates were computed in both broad (h^2b) and narrow senses (h^2n) for

F_2 generation according to Allard (1960) and Mather (1949). While the expected genetic advance under selection (Δg) was computed according to Johnson *et al* (1955). Also, this expected gain was expressed as a percentage of F_2 mean ($\Delta g\%$) according to Miller *et al* (1958).

RESULTS AND DISCUSSION

Mean performance:

Mean and variance of the studied traits in the five crosses for six populations P_1, P_2, F_1, F_2, BC_1 and BC_2 under two levels of irrigation are presented in Table (2). Data in this analysis table indicted that there were significant differences among generations in all traits under study. The F_1 mean values exceeded the mid values of the two parental means for most of studied traits in the five crosses under the two irrigation treatments. The F_2 population mean performance values were intermediate (between the two parents and less than F_1 mean performance values for grain yield and its components; number of spike/plant, number of grains/spike, 1000-grain weight indicating the importance of non-additive components of genetic variance for the studied traits under normal irrigation and water stress conditions.

However, the two populations (BC_1 and BC_2) mean performance values varied under the two conditions and each trait tended toward the mean of its recurrent parent. Similar results were obtained by El-Sayed (2007) and El-Shawy (2008).

Heterosis, Inbreeding depression and potence ratio:

Heterosis were expressed as the percentage deviation of F_1 mean performance from the better and mid parent for all traits. In this concern, percentages of heterosis over better parent and mid parents values under normal and water stress conditions are presented in Table (3). Positive significant or highly significant heterosis over mid and better parent values were obtained for; plant height in cross 3 at normal and water stress conditions, cross 5 under normal irrigation and cross 1 under water stress condition; spike length in the two crosses 1 and 2 at the two conditions, cross 4 under normal and cross 3 under water stress; number of spikes/plant in the three crosses 1, 3 and 5 at the two stress conditions and cross 2 under normal condition; number of grain/spikes in all crosses under both conditions except for cross 5 at water stress condition; 100-grain weight in cross 4 under normal and water stress conditions and for grain yield/plant in the cross 1 at the two conditions, 2 and 3 under normal and 4 and 5 under water stress condition. While negative significant heterosis for mid and better parent were obtained for, number of spikes/plant in cross 4 under normal condition. Similar results were obtained by Budak (2000), El-Seidy and Khattab (2000), Sharma *et al* (2002), El-Bawab (2003), El-Sayed (2007), El-shawy (2008), Amer (2010) and Eid (2010).

Inbreeding depression measured as reduction in performance of F_2 generation due to inbreeding presented in Table (3). Results showed that significant positive values for, spike length in all studied crosses at the two conditions except for cross 5 under stress; number of spike/plant in the crosses, 1and 3 at the two conditions, cross 2 under normal and cross 4 under stress; 100-grain weigh in all studied crosses except for cross 5 at the two conditions and for grain yield/plant in cross 1 at both condition and cross 4 under water stress condition.

Potence ratio refer to over dominance for most crosses in all studied traits at the two conditions, where its values were exceeded unity. On the other hand, some values of potence ratio in some crosses were less than unity indicating partial dominance in these crosses. Similar results were obtained by El-Seidy (1997b), Yadav *et al* (2002b) and El-Bawab (2003), El-Sayed (2007) and El-Shawy (2008)

Table (2): Means ($\bar{X}$) and variances (S^2) of P_1, P_2, F_1, F_2, BC_1 and BC_2 populations of five crosses for plant height, spike length and number of spikes / plant under normal and water stress conditions.

Traits	Crosses	Statistical Parameter	Normal						Stress					
			P1	P2	F1	F2	BC1	BC2	P1	P2	F1	F2	BC1	BC2
Plant height	1	$\bar{X}$	90.57	87	89.5	92.82	92.96	85.33	83	82.97	85.67	84.4	87.01	83.89
		S^2	8.74	5	5.67	106.67	81.98	76.31	9.06	5.59	6.33	75.8	68.82	57.53
	2	$\bar{X}$	91	79	87.2	86.12	84.33	80.53	83.1	76.43	82	84.92	82.27	78.76
		S^2	8	7.48	6.96	93.31	71.47	73.93	9.06	8.25	6.21	64.13	57.63	54.24
	3	$\bar{X}$	86	78.63	90	91.63	87.13	83.53	77.4	76.13	87	84.74	81.79	80.28
		S^2	9.31	7.2	7.34	93.81	62.68	55.93	9.7	8.15	6.9	94.13	87.93	85.58
	4	$\bar{X}$	92.5	78.27	86.3	90.93	85.95	79.35	86.9	77.57	82.83	86.12	83	78.07
		S^2	6.81	4.96	5.04	97.72	66.67	90.39	7.96	5.84	5.94	62.03	46.89	57.36
	5	$\bar{X}$	86.83	76.63	88	91.1	75.47	76.27	83.87	76.27	83.4	81.75	73.15	74.41
		S^2	4.63	7.48	6.21	86.75	73.77	53.85	5.64	9.44	8.52	72.97	63.18	59.76
Spike length	1	$\bar{X}$	7.70	6.87	7.80	7.50	7.91	7.17	7.63	6.67	7.73	7.14	7.75	7.04
		S^2	0.36	0.46	0.79	1.92	1.71	1.77	0.31	0.44	0.62	2.21	1.62	1.98
	2	$\bar{X}$	7.73	8.57	9.60	7.71	8.81	8.69	7.57	8.10	8.70	7.55	8.55	8.11
		S^2	0.48	0.53	0.66	1.68	1.07	1.43	0.25	0.23	0.63	2.25	1.68	1.61
	3	$\bar{X}$	7.50	8.63	8.30	7.44	7.43	7.61	7.30	8.17	8.20	7.37	7.04	7.31
		S^2	0.26	0.52	0.22	1.66	1.22	1.16	0.49	0.21	0.30	2.21	1.90	1.97
	4	$\bar{X}$	7.40	5.40	7.50	6.90	6.99	6.89	7.23	5.17	7.13	6.64	6.95	6.57
		S^2	0.25	0.25	0.26	2.63	2.31	2.47	0.60	0.14	0.60	2.48	2.11	2.06
	5	$\bar{X}$	6.87	8.53	7.90	7.53	6.95	7.21	6.63	8.10	7.40	7.24	6.69	7.25
		S^2	0.46	0.67	0.30	2.23	1.89	1.93	0.38	0.23	0.25	2.31	1.95	2.11
Number of spikes / plant	1	$\bar{X}$	11.13	12.90	13.30	10.65	10.44	11.20	8.00	9.17	10.47	8.39	7.41	8.53
		S^2	0.52	0.62	0.64	7.30	5.68	5.62	0.55	0.65	0.58	7.98	5.81	6.95
	2	$\bar{X}$	11.00	12.70	13.60	11.80	11.35	12.01	8.10	9.17	9.10	9.28	7.81	8.92
		S^2	0.52	0.69	0.32	8.86	5.20	6.80	0.58	0.73	0.43	10.89	6.13	7.75
	3	$\bar{X}$	10.70	12.73	13.80	11.57	9.84	9.91	7.60	9.13	10.60	9.33	7.73	7.76
		S^2	0.63	0.72	0.48	9.82	7.46	6.68	0.66	0.71	0.32	11.06	7.01	9.89
	4	$\bar{X}$	12.40	12.90	12.53	12.37	10.92	10.87	9.43	10.50	10.13	9.26	7.81	8.03
		S^2	0.51	0.42	0.35	10.80	7.91	8.52	0.60	0.95	0.45	8.85	6.69	5.03
	5	$\bar{X}$	12.97	12.60	13.20	12.37	10.23	10.29	9.23	9.30	10.37	9.79	8.04	7.71
		S^2	0.60	0.71	0.41	11.35	10.29	8.99	0.70	0.72	0.55	9.78	7.01	6.13

Cross 1 (Sico × Giza124); cross 2 (Sico × Line-2); cross 3 (Giza 2000 × Line-2), cross 4 (Giza 121 × Line-1) and cross 5 (Giza 124 × Line-2)

Table (2) cont. :

Traits	Crosses	Statistical Parameter	Normal P1	Normal P2	Normal F1	Normal F2	Normal BC1	Normal BC2	Stress P1	Stress P2	Stress F1	Stress F2	Stress BC1	Stress BC2
	1	$\bar{X}$	62.80	53.00	64.80	56.76	61.84	56.64	61.20	52.40	63.60	55.44	59.36	55.36
		S^2	9.27	7.80	8.30	95.56	85.60	84.88	6.41	7.21	8.94	75.22	46.29	63.80
	2	$\bar{X}$	63.20	61.40	70.80	59.78	67.60	66.16	61.80	60.80	68.60	58.44	64.24	63.12
		S^2	8.75	9.01	6.40	103.62	79.14	69.06	5.75	6.89	6.59	97.97	57.18	67.05
Number of grains / spike	3	$\bar{X}$	57.00	61.60	63.60	57.18	57.44	59.68	56.60	61.00	63.20	56.70	55.36	54.40
		S^2	9.31	8.95	8.94	74.74	57.57	60.22	9.14	6.80	9.27	99.24	85.21	80.78
	4	$\bar{X}$	57.00	51.40	60.20	56.02	54.00	53.84	56.00	50.80	58.80	55.50	52.24	51.28
		S^2	8.31	6.63	8.58	98.51	93.41	87.54	13.24	9.27	8.23	105.45	95.13	93.15
	5	$\bar{X}$	53.00	61.30	62.40	57.66	53.12	56.16	52.00	60.60	58.20	54.96	52.16	54.00
		S^2	7.59	8.55	6.39	94.56	82.40	82.35	7.72	7.21	5.27	91.54	71.00	83.32
	1	$\bar{X}$	5.14	4.74	4.95	4.88	5.02	4.85	5.02	4.70	4.90	4.85	4.92	4.72
		S^2	0.03	0.05	0.04	0.19	0.13	0.14	0.05	0.06	0.05	0.20	0.13	0.15
	2	$\bar{X}$	5.16	4.15	4.77	4.75	4.77	4.45	4.99	4.10	4.70	4.68	4.74	4.35
		S^2	0.03	0.06	0.06	0.20	0.18	0.16	0.04	0.05	0.06	0.28	0.21	0.18
100-grain weight	3	$\bar{X}$	5.30	4.13	5.14	4.91	4.99	4.10	5.28	4.09	5.04	4.84	4.86	3.98
		S^2	0.03	0.06	0.03	0.17	0.12	0.11	0.02	0.05	0.03	0.22	0.18	0.17
	4	$\bar{X}$	5.25	5.20	5.28	5.21	5.19	5.25	5.18	5.14	5.19	5.06	5.02	5.09
		S^2	0.02	0.05	0.03	0.22	0.15	0.16	0.05	0.03	0.02	0.20	0.14	0.15
	5	$\bar{X}$	4.76	4.15	4.62	4.41	4.45	4.20	4.71	4.10	4.52	4.36	4.31	4.13
		S^2	0.06	0.03	0.04	0.12	0.11	0.10	0.05	0.04	0.04	0.17	0.15	0.14
	1	$\bar{X}$	22.92	25.78	26.47	21.31	22.39	23.90	22.83	22.00	24.13	18.04	20.54	21.12
		S^2	5.68	5.85	4.23	58.05	38.31	33.73	5.95	4.07	3.82	47.68	39.01	34.21
	2	$\bar{X}$	23.12	21.00	24.27	24.04	22.52	24.02	23.06	19.96	23.20	23.01	21.30	22.82
		S^2	5.79	5.49	5.64	67.50	44.78	38.60	6.36	6.63	4.43	98.41	68.09	89.37
Grain yield / plant	3	$\bar{X}$	25.47	21.50	25.76	22.94	23.61	21.65	24.72	20.01	23.36	22.11	22.34	20.79
		S^2	5.84	6.99	3.49	63.12	47.81	37.97	6.46	6.48	4.68	57.88	55.53	44.12
	4	$\bar{X}$	24.61	27.12	26.10	26.09	21.93	25.85	19.86	22.34	24.94	20.24	17.71	20.26
		S^2	3.93	2.75	4.61	71.60	55.67	42.41	4.85	5.65	5.36	61.67	59.37	41.57
	5	$\bar{X}$	25.96	21.04	25.34	24.39	22.75	21.85	21.55	19.99	22.54	21.86	19.81	19.22
		S^2	5.98	6.71	3.06	69.62	39.28	64.33	4.11	6.51	5.02	81.74	74.30	70.28

Cross 1 (Sico × Giza124); cross 2 (Sico × Line-2); cross 3 (Giza 2000 × Line-2), cross 4 (Giza 121 × Line-1) and cross 5 (Giza 124 × Line-2)

Table (3): Heterosis, inbreeding depression and potence ratio in five crosses for all studied traits under normal and water stress condition.

Traits	Crosses	Normal				Stress			
		Heterosis		ID	PR%	Heterosis		ID	PR%
		MP	BP			MP	BP		
Plant height	1	0.81	-1.18	-3.71	0.40	3.23**	3.21**	1.48	161.00
	2	2.59**	-4.18**	1.24	0.37	2.80**	-1.32	-3.56	0.67
	3	9.34**	4.65**	-1.81	2.09	13.33**	12.40**	2.60	16.16
	4	1.07*	-6.70**	-5.37	0.13	0.73	-4.68**	-3.97	0.13
	5	7.67**	1.35*	-3.52	1.23	4.16**	-0.56	1.98	0.88
Spike length	1	7.09**	1.30**	3.85*	1.24	8.16**	1.35**	7.63**	1.21
	2	17.79**	12.02**	19.69**	-3.48	11.06**	7.41**	13.18**	-3.25
	3	2.89**	-3.82**	10.32**	-0.41	6.03**	0.37**	10.08**	-1.08
	4	17.19**	1.35**	8.04**	1.10	15.05**	-1.34**	6.96**	0.90
	5	2.60**	-7.39**	4.68**	-0.24	0.45**	-8.64**	2.16	-0.05
Number of spikes / plant	1	10.68**	3.10**	19.95**	-1.45	21.94**	14.14**	19.84**	-3.23
	2	14.77**	7.09**	13.21**	-2.06	5.41**	-0.76**	-1.98	-0.88
	3	17.78**	8.41**	16.14**	-2.05	26.69**	16.10**	11.98**	-2.91
	4	-0.92**	-2.84**	1.30	0.47	1.67**	-3.49**	8.59**	-0.31
	5	3.26**	1.77**	6.29	2.27	11.87**	11.47**	5.56	-33.00
Number of grains / spike	1	11.92**	3.18**	12.41	1.41	11.97**	3.92**	12.83	1.55
	2	13.64**	12.03**	15.56	9.44	12.83**	11.00**	14.81	15.60
	3	7.25**	3.25**	10.09	-1.87	7.48**	3.61**	10.28	-2.00
	4	11.07**	5.61**	6.94	2.14	10.11**	5.00**	5.61	2.08
	5	9.19**	1.79*	7.60	-1.27	3.37**	-3.96**	5.57	-0.44
100-grain weight	1	0.16**	-3.70**	1.41**	0.04	0.81**	-2.39**	1.02*	0.24
	2	2.48**	-7.60**	0.38	0.23	3.37**	-5.81**	0.43	0.34
	3	9.01**	-3.02**	4.47**	0.73	7.50**	-4.58**	3.96**	0.59
	4	1.05**	0.57**	1.31**	2.20	0.57**	0.22**	2.53**	1.33
	5	3.72**	-2.94**	4.65**	0.54	2.63**	-4.09**	3.58**	0.38
Grain yield / plan	1	8.69**	2.66**	19.50**	-1.48	7.67**	5.70**	25.26**	4.16
	2	10.02**	4.97**	0.95	2.08	7.87**	0.61	0.82	1.09
	3	9.69**	1.14*	10.95	1.15	4.45**	-5.50**	5.35	0.42
	4	0.92*	-3.76**	0.02	-0.19	18.21**	11.66**	18.87*	-3.10
	5	7.83**	-2.39**	3.73	0.75	8.54**	4.61**	3.03	2.27

(*) and (**) significant at 0.05 and 0.01 levels probability, respectively.
Cross 1 (Sico × Giza124); cross 2 (Sico × Line-2); cross 3 (Giza 2000 × Line-2), cross 4 (Giza 121 × Line-1) and cross 5 (Giza 124 × Line-2)

Estimation of type of gene action:

Six parameter model was employed to allow estimation of the additional parameters that are necessary to specify the effects of interaction of non-allelic genes. Testing for non- allelic interaction with the six parameter model and type of epistasis under normal and water stress conditions are given in Table (4).

The estimate of mean parameter (m) for all studied attributes which reflected the contribution was found to be highly significant of the five crosses under normal and water stress conditions. Additive gene effect (a) is quiet small in magnitude relative to the dominance gene effects. Additive gene effect was positive and significant or highly significant for plant height in the three crosses 1, 2 and 4 under the two conditions and cross 3 under normal irrigation only; spike length in the cross 1 only under the two conditions and cross 2 under stress condition; number of grains/spike in the cross 1 only under the two conditions and 100-grain weight in the four crosses 1, 2, 3 and 5 under the two conditions suggesting the potential for obtaining further improvement of these traits by using pedigree selection program.

On the other hand, significant or highly significant negative additive effects were obtained for spike length in cross 5 only under water stress condition; number of spikes/plant in cross 1 under normal and water stress conditions and cross 2 under stress. As well as for; number of grains/spike in the cross 5 under normal irrigation and grain yield/plant in cross 4 under the two stress conditions indicating that the additive effects were less important in the inheritance of these traits.

These results in harmony with those obtained by Bhatnagar *et al* (2001), Singh *et al* (2002), Eid (2006), El-Sayed (2007) and El-Shawy (2008). The estimates of dominance (d) effects (Table 4) were significant or highly significant for most studied traits except for plant height in cross 3 only under stress; spike length in crosses 3 under the two conditions, cross 1 under normal and cross 5 under stress condition; number of spikes/plant in the two crosses 1 in the two conditions and 2 under normal irrigation; number of grains/spike in the three crosses 5 at the two stress conditions, 4 under normal and 3 under stress conditions; 100-grain weight in cresses 1 and 4 at the two conditions and cross 5 under normal condition and grain yield/plant in crosses 2 and 3 at the two conditions and cross 4 under stress condition, indicating the importance of dominance gene effects in the inheritance of these traits. On the other hand, significant of (a) and (d) components indicated that both additive and dominance gene effects were important in the inheritance of these traits and selecting desirable traits would be effective in the late generations. These results in agreement with El-Seidy (1997a), El-Seidy (1997b), Eid (2006), El-Sayed (2007) and El-shawy (2008). Significant or highly significant positive additive × additive (aa) types of epistasis was detected for; spike length in cross 2 only at the two stress conditions; number of grains/spike in the two crosses 1 and 2 at the two conditions and for grain yield/plant in cross1 under the two conditions, indicating that these traits had increasing genes and selection efficiency development. While, significant or highly significant negative additive × additive type was found for the rest of crosses under the two conditions except for; plant height in cross 1 under stress; spike length in crosses 1,3 and 4 at the two conditions and cross 5 under stress condition; number of spikes/plant in cross 1 under both conditions and cross 2 under normal condition; number of grains/spike in cross 3 at the two conditions and 100-grain weight in crosses 1 and 4 under the two conditions and for grain yield in crosses 2 and 3 at the two conditions and cross 4 under stress condition only (table 4). Similar results were obtained by El-Hosary *et al* (1992), Abul-Naas *et al* (1993), El-Seidy (1997a), El-Seidy (1997b), Nawar *et al* (1999), Bhatnagar *et al* (2001) and Sharma *et al* (2003). Significant or highly significant positive additive × dominance (ad) type of epistasis was found for; plant height in the cross 1 at the two conditions; spike length in the cross 2 at the two conditions and cross 5 under normal condition; number of spikes/plant in cross 3 under normal condition; number of grains/spike in cross 3 under stress; 100-grain weight in the cross 3 at the two stress conditions. On the other hand significant or highly significant negative additive × dominance types of epistasis was found for; plant height in the cross 5 at the two conditions; spike length in the cross 4 at the two conditions; 100-grain weight in the cross 2 under normal condition and grain yield/plant in the cross 2 at the two conditions and cross 4 under normal condition. The dominance × dominance (dd) epistasis gene effect was significant or highly significant positive for the most studied traits in all crosses except for; plant height in the cross 1 under stress; spike length in the two crosses 1 and 4 at the two conditions; number of grains/spike in the two crosses, 1 at the two conditions and 3 under normal; 100-grain weight in the two crosses 1 and 4 at the two conditions and grain yield/plant in the three crosses 1, 2 and 3 under the two conditions. These results confirm the importance role of dominance x dominance gene action in the genetic behavior. Similar approaches were reported by Abul-Naas *et al* (1993), El-Seidy (1997a), Eid (2006), El-sayed (2007) and El-shawy (2008).

Heritability and expected genetic advance from selection:

Heritability estimates in both broad and narrow senses and expected genetic advance from selection for studied traits are presented in Table (5). Heritability estimates in broad sense were relatively high for all studied traits in all crosses and ranged from 65.16% in cross5 and 73.54% in cross1 for 100-grain weight to 96.23% in cross 4 and 95.45 % in cross 3 for number of spike/plant under normal and water stress conditions respectively. While, heritability estimates in narrow sense were low to moderate for all studied traits in all crosses and ranged from15.67% in cross 3 under stress condition for plant height and 16.32% in cross 4 under stress condition for number of grains/spike to 73.19 % in cross 2 for number of grains/spike and 76.49 % in cross 2 for grain yield/plant under water stress and normal conditions, respectively, indicating that these traits greatly affected by non-additive and environmental effects. These results were coincident with those reported by Abul-Naas *et al* (1993), El-Seidy (1997a), Singh and Singh (1999), El-Bawab (2003), Eid (2006), El-Sayed (2007) and Shawy (2008). The expected genetic advance as percent of F_2 ranged from (5.6%) for 100-grain weight in cross 2 to (55.9%) for grain yield/plant in cross 1 under normal condition and ranged from (3.70%) for plant height in cross 3 to (53.16%) for number of spikes/plant in cross 2 under water stress condition. These results indicated the possibility of practicing selection in early generations and obtain high yielding genotypes. Therefore, selection during those particular populations should be effective and satisfactory for successful breeding purposes. The results of this study indicated that estimate of epistasis, dominance and additive gene actions may have been influenced by genotype-environment interactions. It can be concluded that the degree of improving studied traits based on the high heritability values and positive additive genetic advance shown by the different traits, especially; number of spikes/plant, 100-grain weight and grain yield /plant. Determinant genetic effects of the phenotypic expression of these traits are fundamentally of the additive type. For this reason, a high response should be achievable after several selection cycles. The development of adapted varieties to the arid conditions depends on improvement of potential yield and yield evaluation in different environments. Generally, the most promising crosses were the two crosses 1 and 2, were found to be higher in magnitude which had high genetic advance associated with high heritability and would be interested in breeding programs for evolving better barley yield under stress environments.

Table (4): Type of gene action estimated by generation means in five crosses for all studied traits under normal and water stress conditions.

Traits	Crosses	Normal (m)	Normal (a)	Normal (d)	Normal (aa)	Normal (ad)	Normal (dd)	Stress (m)	Stress (a)	Stress (d)	Stress (aa)	Stress (ad)	Stress (dd)
Plant height	1	92.82**	7.63**	-13.96**	-14.68**	5.84**	14.66*	84.40**	3.12*	6.90*	4.21	3.10*	-8.73
	2	86.12**	3.80**	-12.53**	-14.73**	-2.20	29.40**	84.92**	3.51**	-15.39**	-17.63**	0.17	19.11**
	3	91.63**	3.60**	-17.52**	-25.20**	-0.08	28.50**	84.74**	1.51	-4.59	-14.83**	0.87	18.23**
	4	90.93**	6.60**	-32.23**	-33.15**	-0.52	45.93**	86.12**	4.93**	-21.75**	-22.35**	0.27	30.35**
	5	91.10**	-0.80	-54.67**	-60.93**	-5.90**	96.93**	81.75**	-1.27	-28.55**	-31.88**	-5.07**	63.69**
Spike length	1	7.50**	0.73**	0.68	0.16	0.32	-0.15	7.14**	0.71**	1.58**	1.00	0.22	-0.81
	2	7.71**	0.12	5.62**	4.17**	0.54**	-3.69**	7.55**	0.44*	3.96**	3.09**	0.71**	-3.33**
	3	7.44**	-0.19	0.54	0.31	0.38	2.35**	7.37**	-0.27	-0.32	-0.79	0.16	3.95**
	4	6.90**	0.09	1.27*	0.17	-0.91**	-0.13	6.64**	0.37	1.43*	0.49	-0.66**	-0.87
	5	7.53**	-0.27	-1.60**	-1.80**	0.57*	4.68**	7.24**	-0.56*	-1.03	-1.07	0.17	2.71**
Number of spikes / plant	1	10.65**	-0.76*	1.98	0.69	0.12	6.66**	8.39**	-1.12**	0.22	-1.67	-0.54	7.87**
	2	11.80**	-0.67	1.26	-0.49	0.18	4.67**	9.28**	-1.11**	-3.19**	-3.65**	-0.57	5.65**
	3	11.57**	-0.07	-4.72**	-6.80**	0.95*	18.34**	9.33**	-0.03	-4.10**	-6.33**	0.74	13.28**
	4	12.37**	0.05	-6.02**	-5.91**	0.30	12.70**	9.26**	-0.21	-5.21**	-5.37**	0.32	13.89**
	5	12.37**	-0.07	-8.02**	-8.44**	-0.25	19.37**	9.79**	0.33	-6.57**	-7.67**	0.37	15.44**
Number of grains / spike	1	56.76**	5.20**	16.82**	9.92**	0.30	-1.48	55.44**	4.00**	14.48**	7.68*	-0.40	3.68
	2	59.78**	1.44	36.90**	28.40**	0.54	-29.72**	58.44**	1.12	28.76**	20.96**	1.12	-16.88**
	3	57.18**	-2.24	9.82**	5.52	0.06	6.04	56.70**	0.96	-2.88	-7.28	3.16*	31.76**
	4	56.02**	0.16	-2.40	-8.40*	-2.64	21.52**	55.50**	0.96	-9.56*	-14.96**	-1.64	32.32**
	5	57.66**	-3.04*	-6.83	-12.08**	1.11	32.62**	54.96**	-1.84	-5.62	-7.52*	2.46	24.20**
100-grain weight	1	4.88**	0.17**	0.22	0.21	-0.03	-0.16	4.85**	0.20**	-0.08	-0.12	0.04	0.36
	2	4.75**	0.32**	-0.44*	-0.56**	-0.18*	0.96**	4.68**	0.39**	-0.39*	-0.54**	-0.05	0.85**
	3	4.91**	0.89**	-1.04**	-1.46**	0.31**	2.99**	4.84**	0.88**	-1.34**	-1.69**	0.29**	3.47**
	4	5.21**	-0.07	0.09	0.04	-0.09	0.10	5.06**	-0.07	0.01	-0.03	-0.09	0.52
	5	4.41**	0.25**	-0.16	-0.32*	-0.05	1.17**	4.36**	0.18**	-0.41*	-0.53**	-0.13	1.48**
Grain yield / plan	1	21.31**	-1.51	9.47**	7.35**	-0.08	1.70	18.04**	-0.58	12.90**	11.18**	-0.99	-1.40
	2	24.04**	-1.50	-0.86	-3.07	-2.56*	2.65	23.01**	-1.52	-2.09	-3.78	-3.07*	4.94
	3	22.94**	1.96	1.03	-1.24	-0.02	9.21	22.11**	1.55	-1.19	-2.18	-0.80	7.37
	4	26.09**	-3.92**	-8.58**	-8.81**	-2.66*	17.17**	20.24**	-2.55*	-1.16	-5.00	-1.31	21.15**
	5	24.39**	0.89	-6.54*	-8.38**	-1.57	16.86**	21.86**	0.59	-7.61*	-9.38**	-0.19	17.95**

(*) and (**) significant at 0.05 and 0.01 levels probability, respectively.
Cross 1 (Sico × Giza124); cross 2 (Sico × Line-2); cross 3 (Giza 2000 × Line-2), cross 4 (Giza 121 × Line-1) and cross 5 (Giza 124 × Line-2)

Table (5): Heritability percentage in broad (h^2b) and narrow (h^2n) senses and expected genetic advance from selection (Δg) in five crosses for all studied traits under normal and water stress conditions.

Traits	Crosses	Normal				Stress			
		Heritability%		Genetic advance		Heritability%		Genetic advance	
		h2(b)	h2(n)	Δg	Δg%	h2(b)	h2(n)	Δg	Δg%
Plant height	1	94.12	51.61	10.98	11.83	90.99	33.31	5.97	7.08
	2	92.12	44.19	8.79	10.21	88.41	25.55	4.21	4.96
	3	91.69	73.57	14.68	16.02	91.59	15.67	3.13	3.70
	4	94.41	39.27	8.00	8.80	89.65	31.94	5.18	6.02
	5	92.93	52.89	10.15	11.14	88.99	31.52	5.55	6.78
Spike length	1	68.80	18.71	0.53	7.11	77.62	36.71	1.12	15.74
	2	65.26	50.76	1.35	17.57	80.57	53.48	1.65	21.87
	3	81.78	56.53	1.50	20.15	85.14	24.51	0.75	10.17
	4	90.36	17.91	0.60	8.67	80.37	32.07	1.04	15.68
	5	80.54	28.88	0.89	11.80	88.03	24.43	0.76	10.56
Number of spikes / plant	1	91.73	45.18	2.51	23.62	92.61	40.04	2.33	27.77
	2	94.79	64.53	3.96	33.52	95.02	72.57	4.93	53.16
	3	94.12	56.00	3.62	31.24	95.45	47.21	3.23	34.66
	4	96.23	47.87	3.24	26.20	93.08	67.61	4.14	44.73
	5	95.31	30.18	2.09	16.93	93.56	65.61	4.23	43.17
Number of grains / spike	1	91.19	21.60	4.35	7.66	89.53	53.64	9.58	17.29
	2	92.63	56.98	11.95	19.99	93.41	73.19	14.92	25.54
	3	87.91	42.39	7.55	13.20	91.31	32.74	6.72	11.85
	4	91.85	16.32	3.34	5.95	90.76	21.45	4.54	8.18
	5	92.35	25.76	5.16	8.95	93.04	31.42	6.19	11.27
100-grain weight	1	78.43	54.26	0.48	9.86	73.54	62.48	0.58	11.97
	2	73.66	28.95	0.27	5.60	81.39	62.27	0.68	14.55
	3	77.62	62.04	0.53	10.70	85.06	39.96	0.38	7.93
	4	85.29	58.74	0.57	10.91	84.95	51.06	0.47	9.24
	5	65.16	25.13	0.18	4.10	75.00	27.88	0.24	5.44
Grain yield / plan	1	91.39	75.89	11.91	55.90	90.74	46.45	6.61	36.63
	2	91.64	76.48	12.94	53.85	94.45	39.99	8.17	35.51
	3	92.15	64.09	10.49	45.72	90.37	27.83	4.36	19.73
	4	94.45	63.01	10.98	42.09	91.40	36.33	5.88	29.04
	5	93.24	51.17	8.80	36.05	93.68	23.12	4.31	19.70

Cross 1 (Sico × Giza124); cross 2 (Sico × Line-2); cross 3 (Giza 2000 × Line-2), cross 4 (Giza 121 × Line-1) and cross 5 (Giza 124 × Line-2)

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دراسات وراثية على تحمل بعض هجن الشعير للجفاف

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أجريت هذه الدراسة بمزرعة محطة البحوث الزراعية بسخا خلال ثلاث مواسم ٢٠٠٧/٢٠٠٨، ٢٠٠٨/٢٠٠٩ و٢٠٠٩/٢٠١٠ لدراسة تأثير الفعل الجينى باستخدام نظام العشائر الستة (الأب الأول، الأب الثانى، الجيل الأول، الجيل الثانى، الهجين الرجعى الأول و الهجين الرجعى الثانى) لخمسة هجن من الشعير هى : الهجين الأول (سايكو x جيزة ١٢٤)، الهجين الثانى (سايكو x سلالة- ٢)، الهجين الثالث (جيزة ٢٠٠٠ x سلالة- ٢)، الهجين الرابع (جيزة ١٢١ x سلالة- ١) والهجين الخامس (جيزة ١٢٤ x سلالة- ٢) . تم زراعة العشائر الستة لهذه الهجن تحت ظروف الرى العادية والإجهاد المائى. تم دراسة محصول الحبوب ومكوناته وبعض الصفات الخضرية المرتبطة به. أظهرت النتائج أن متوسطات الأجيال كانت عالية المعنوية بالنسبة لكل الصفات فى كل الهجن. تشير النتائج بصورة عامة إلى وجود تفاعل بين العوامل غير الأليلية بالنسبة لكل الصفات فى كل الهجن ، كما أشارت النتائج إلى أهمية تأثيرات كل من الفعل الوراثى المضيف والسيادى والتى اختلفت تبعا للصفات والهجن تحت كلا المعاملتين. أما بالنسبة لمكونات التفاعل فان التفاعل السيادى x السيادى كان ذو تأثير أكبر من تأثير الفعل الوراثى المضيف x المضيف و المضيف x السيادى فى معظم الصفات المدروسة. تقديرات عالية المعنوية موجبة لقوة الهجين بالمقارنة بمتوسط الأبوين والأب الأفضل تم الحصول عليها فى معظم الصفات المدروسة تحت كلا المعاملتين. بالنسبة للتقديرات الخاصة بدرجة التوريث فان درجة التوريث بالمعنى الواسع تراوحت مابين متوسطة إلى مرتفعة أما درجة التوريث بالمعنى الضيق فتراوحت مابين منخفضة إلى متوسطة وذلك بالنسبة لكل الصفات فى كل الهجن. كما أن التحسين الوراثى المتوقع نتيجة الانتخاب تراوح مابين منخفض إلى مرتفع بالنسبة لمعظم الصفات المدروسة فى كل الهجن. هذه النتائج تشير إلى إمكانية إجراء الانتخاب فى الأجيال الانعزالية المبكرة والحصول على تراكيب وراثية عالية المحصول. بصورة عامة فان أفضل الهجن المبشرة كانت الهجين الأول والثانى حيث أعطوا قيم عالية للتحسين الوراثى المتوقع نتيجة للانتخاب وكذلك درجة الوريث مما يشير إلى أهمية هذه الهجن فى برامج التربية لتحسين معظم الصفات المحصولية فى الشعير.

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المجلة المصرية لتربية النبات ١٥ (٢):٢٥- ٣٧ (عدد خاص)