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ESTIMATION OF GENETIC PARAMETERS, CORRELATION AND PATH COEFFICIENTS IN F_3 OF SOME BARLEY FAMILIES UNDER SALINE CONDITIONS

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ABSTRACT: Five F_3 selected families of barley were evaluated at Ras Sudr Research Station of (DRC), South Sinai Governorate in 2003/2004 growing season under salinity condition of soil and irrigation water of about 9875 and 11000 ppm, respectively. At 75 days after sowing, 10 guarded plants were selected randomly to estimate chemical contents in random sample of each F_3 family leaves i.e. proline (in fresh samples), K/Na ratio, Mg, Cl and SO_4 (in dry samples). At harvest, fifteen competitive plants from each plot were selected to record observations on plant height, number of spikes/plant, spike length, number of grains/spike, 1000-grain weight and grain yield/plant. Genetic parameter, heritability in broad and narrow, simple correlation, and path analysis were calculated. The obtained results can be summarized as follows:

The results indicated that the dominance genetic variance accounted the major part in controlling, the additive genetic portion affeared to be the prevailed type controlling K/Na ratio and sulfate (SO_4) contents on the contrary, the dominance genetic component was found to be more important in controlling proline and magnesium contents in most crosses. Heritability estimate in broad sense were high, whereas it was moderately high in narrow sense for chemical component. The additive genetic portion affeared to be prevailed type controlling 1000-grain weight, while, the dominance genetic component was found to be more important in controlling number of grains/spike and grain yield /plant in most crosses. Heritability estimate in broad sense were high whereas, it was

moderately low in narrow sense for grain yield and its attributes. Correlations between grain yield/ plant and each of the chemical composition of leaves as well as yield components were positive and significant in most cases except for Cl content which was negatively correlated with grain yield/ plant. The total contribution of each chemical components in leaves showed that proline content was the most powerful determinant of grain yield in Giza-123 × ACSAD-5 F_3 families as it contributed by 20.33%. In general, chemical contents could be arranged over all studied F_3 populations as their importance as follows i.e. SO_4, proline, Mg, K/Na and Cl contents. The main source of grain yield variation under salinity condition was for 1000-grain weight followed by number of grains/spike and number of spikes/ plant in three or more of F_3 families. Such highly contributed traits easily measured and gave a valuable idea for selection to yield improvement under saline environments.

Key words: Barley (*Hordeum vulgar* L.), generation, salinity, heterosis, heritability and path coefficient analysis.

INTRODUCTION

Improvement cereal crops as barley under saline conditions is more difficult than breeding under favorable conditions. The greater degree of difficulty is due to increased complexity of genotype-environment interaction association with yield and its contributing traits, choice an effective breeding program for improving barley under saline conditions such South Sinai, Egypt.

In the initial stages of any breeding programs, the breeder interest to knowledge about gene action and genetic system controlling the studied characters. Estimation of additive (D) and dominance (H) genetic components was estimated using Mather and Jinks (1982). The dominance genetic variance accounted the major part in controlling proline and chemical leaves dry weight i.e. Mg contents in F_3 generation. Hassan and Nahed (2002), also additive genetic variance was played the major role in controlling K/Na and SO_4 contents, with heritability in broad sense more than 45% for leaves chemical contents and ranged from 18 up to 45% in narrow sense. Hassan and Nahed (2002) indicated the importance of dominance gene action controlling number of grains/spike and grain yield/plant. Whereas the additive was more important for number of spikes/plant and 1000-grain weight. The heritability in broad sense was more than 55 % for all studied yield characters while, and in narrow sense heritability ranged from 25 to 55 % in this respect. Also $(H/D)^{05}$ was more than unity for number of grains/ spike, grain yield/ plant Abd El- Satar and Afiah (1999) and Afiah *et al.* (2001).

Most genetic analysis in barley concentrate on the elucidating the mode of inheritance of characters separately. However, it is equally important to study the genetic relationships between different characters so that the consequences of selection for one character on the performance of another can be predicted. The genetic covariance or its standardized from expresses the degree of genetic relationship was insignificant between pairs of characters. The correlation coefficient functionally, a significant relationship implies the pleiotropic effect of the same genes or linkage genes controlling the separate characters and these deducted by El-Sayed *et al.* (1995), Kattab and Afiah (1999) and Sundeep and Parsad (2002).

The progress in research for developing barley varieties for stress tolerance and good agronomic procedures has not been commensurate with the needs because the narrow base of germplasm used and inadequacy of the selection methods to detect genotypes superior under stress environments. In the meantime, many reports identified lines with wide adaptation and ability to withstand the aimed environments outlined using early segregating generations. Hence, many investigators used correlation analysis ascertain relationships between variables and grain yield. Also path-analysis model was utilized to determine the importance of the yield components contributing to grain yield and found that path analysis is useful of them, Hassan and Abdel-Sabour (1991), El-Sayed *et al.* (1995), Afiah and Abdel-Hakim (1999), Afiah *et al.* (2001) and Sundeep and Prasad (2002).

The present investigation was undertaken to obtain information about gene action of genetic system and heritability as well as correlation and path analysis coefficients to decided selection criteria and improving barley productivity under saline condition throughout different steps in breeding programs, So the study was measured the leaves chemicals contents at (75 days) after sowing as well as grain yield/plant and its related characters in the segregating generations of fifth barley crosses made among sixth barley genotypes (local and introduced) were grown and irrigated by water salinity levels from 9000 up to 11000 ppm at Ras Sudr conditions in some families for F_3 generation in barley crosses.

MATERIALS AND METHODS

Six genetically divers barley genotypes i.e. Giza -123 as a local variety , and ICARDA (1,2,3 and 4) and ACSAD-5 were selected from imported collection of ICARDA and ACSAD to build F_1 diallel cross fashion during 2001/2002 season.

The lines number, origin, entry name and pedigree of the parental barley genotypes are shown in Table 1, Salt tolerance genetic materials were chosen after estimating the characters related to salinity in fifteen barley crosses by Hassan and Nahed (2002).

The F_1 plants were maintained to produce F_2 grains. At harvesting date in the second season (2002/ 2003), 60 F_2 plants were selected from each replicate and threshed and sown separately. Grains of each F_2 selected plants were represented by one row 1 m length, 20 cm apart and 5 cm between plants (20 plants / row in each replicate), with 2 rows for each parent to produce F_3 family plants. Five F_3 family seeds of five barley crosses i.e. (Giza-123 x ICARDA-1), (Giza-123 x ICARDA-2), (Giza123 x ICARDA-3), Giza123 x ICARDA-4) and (Giza-123 x ACSAD-5) were sown on 15 November (2003). Each plot

Table 1. Number, Origin, Entry name and pedigree of local and exotic barley genotypes

No.	Origin	Entry name	Pedigree
G1	Egypt	Giza 123	Produce from ARC program.
G2	ICARDA/Lebanon	ICARDA -1	Rihan 03
G3	ICARDA/ Syria	ICARDA -2	Arar 12762 / Be. 2t / 2Y.
G4	ICARDA/ USA	ICARDA- 3	Beecher
G5	ICARDA/ Mexico	ICARDA- 4	Capa /Bar/ 3/Aby/Ch67/B/Mzk/4 Ci/14032
G6	ICARDA/ Syria	ACSAD -5	ACSAD 214 × Arrhcat.

consisted of 9 rows (5 rows for F3 families+2 rows for each parent) in a randomized complete block design with three replicates. The row length was 1m, 20 cm apart and 5 cm within plants.

During this program the genetic materials were evaluated under salinity conditions of soil (ranged from 10550 to 12000 ppm) with 43.8% $CaCO_3$ and artesian irrigation water that started by about 9000 ppm (in the first season, 2002/2003) and increased by 1000 ppm every year to reach 11000 ppm in 2004/2005 season. Ordinary cultural practices for barley production under desert conditions were following during each growing seasons. At 75 days after sowing, 10 guarded plants were selected randomly to measure chemical contents in random sample of F_3 family leaves i.e. proline (in fresh sample), K/Na ratio, Mg and SO_4 in dry samples. At harvest, fifteen competitive plants from each plot were selected to record observations on the grain yield and its attributes i.e. spike length, number of spikes/plant, no. of grains/spike, 1000-grain weight and grain yield /plant.

Statistical Procedure

1. Variance mean of F_3 families were estimated separately as outlined by Mather and Jinks (1982).
2. Portioning of variance was calculated by solving the following equations according to Mather and Jinks (1982):

$$\sigma^2 B = VF_3 = {}^1/_2\, D + {}^1/_{16}\, H + VE/N.$$

$$\sigma^2 W = VF_3 = {}^{1/4}D + {}^{1/8}H + VE$$

VF3= Variance of means of F_3 families.

VF3= Mean variance of F_3 families.

VE= Environmental variance.

3. Heritability in broad sense (T_b) and narrow sense (T_h) were calculated according to Mather and Jinks (1982) as follows:

$$T_b = \frac{3/4\, VD + 3/16\, VH}{3/4\, VD + 3/16\, VH + E} \times 100$$

$$T_n = \frac{3/4\, VD}{3/4\, VD + 3/16\, VH + E} \times 100$$

Where:

VD= The additive genetic variance.

VH=The dominance genetic variance.

VE= The environmental variance.

4. Simple correlation and path coefficient analysis: Calculated according to the covariance analysis as described by Harvey (1990).Path coefficient analysis was caused to calculated according to Dawey and Lu (1959).

RESULTS AND DISCUSSION

Separation out the total genetic variance to its mean items additive (D) and dominance (H) gene effects using dialed analysis methods was performed for the most important growth character appeared to be more associated with yield and its attributes. Also, estimate of the leaves chemical contents in the same age (75 DAS) and its contents related and associated with salinity tolerance when it irrigated and grown under saline condition i.e. proline , K/Na, Mg, and SO_4 in leaves fresh or dry weight. As well as the genetic components of variance were computed for barley yield and as attributes. Partitioning of genetic parameters into additive (D), dominance (H) and environmental effects (E) as well as heritability in broad and narrow sense shown in Tables 2, 3 and 4 for F_3 families under saline conditions of barley crosses each of soil or irrigation water.

Genetic Parameters of Leaves Chemical Contents

Data presented in Table 2 show additive (D), dominance (H), environmental (E) component and heritability in broad and narrow sense, for leaves chemical contents each of fresh and dry weight measured at 75 days after sowing. The results indicated that both additive and dominance genetic components were significant for all chemical components traits. The additive genetic portion affeared to be the prevailed type controlling k/Na ratio and Sulfate (So_4) contents resulting in average degree of dominance was less than unity. There for phenotypic selection was effective for improving these characters under saline condition.

On the contrary, the dominance genetic components was found to be more important in controlling proline and magnesium (Mg) contents in most crosses resulting in average degree at dominance was more than unity .Hereby hybrid breeding method could be operative for improving these characters and support grain yield under saline condition.

The environmental variance was significant for chemical components traits reinforcing the important role of environmental condition on the expression of chemical components.

Heritability estimate in broad sense were high whereas it was moderately high in narrow sense

Table 2. Additive (D), dominance (H), environmental and heritability in broad and narrow sense of F_3 families for leaves chemical contents of barley crosses plant measured at 75 days after sowing

Component	Crosses				
	1	2	3	4	5
	Giza 123×ICARDA-1	Giza 123×ICARDA-2	Giza 123×ICARDA-3	Giza 123×ICARDA-4	Giza 123×ACSAD-5
	Proline content in leaves fresh weight- ppm				
D ± S.E	144.8* ± 57.64	148.9* ± 59.56	196.0** ± 78.1	204.0** ± 81.61	111.4** ± 44.4
H ± S.E	1211.4** ± 48.46	1147.0** ± 45.88	894.0** ± 344.1	1061.0** ± 424.4	1118.1** ± 447.5
E ± S.E	115.1** ± 14.51	98.7** ± 39.48	109.7* ± 43.88	119.6* ± 47.6	84.7* ± 33.88
Hb + S.E	55.3** ± 22.01	54.3* ± 21.72	53.1* ± 21.24	61.4* ± 24.56	64.4** ± 25.6
Hn + S.E	32.4** ± 12.85	36.4* ± 14.56	39.7* ± 15.88	46.4* ± 18.56	28.8** ± 11.52
H/D	8.409	7.703	4.561	5.200	10.036
	(K / Na ratio) contents in leaves dry weight – ppm				
D ± S.E	444.8** ± 177.6	418.8** ± 167.5	367.8* ± 150.4	216.7* ± 86.4	230.4* ± 92.0
H ± S.E	177.6* ± 70.8	109.8* ± 43.6	140.4* ± 56.00	167.5* ± 67.0	167.3* ± 66.9
E ± S.E	67.5* ± 26.8	81.1* ± 32.44	110.0* ± 44.00	58.7 * ± 23.51	61.7* ± 24.68
Hb + S.E	71.5* ± 28.6	66.6** ± 26.4	61.4* ± 24.4	75.1** ± 30.04	68.7* ± 27.48
Hn + S.E	50.1* ± 20.0	41.4* ± 16.56	45.7* ± 18.28	48.1* ± 19.24	40.1* ± 16.04
H/D	0.411	0.262	0.373	0.733	0.684
	Magnesium (Mg) contents in leaves dry weight – ppm				
D ± S.E	104.5* ± 41.6	117.7* ± 46.85	130.6* ± 52.24	167.7* ± 66.8	156.6* ± 62.4
H ± S.E	-445.9* ± 178.9	319.8** ± 17.81	299.7** ± 119.88	-311.7** ± 13.20	410.8* ± 164.32
E ± S.E	15.0* ± 6.00	9.8* ± 3.92	21.7** ± 8.68	7.6* ± 3.04	24.8* ± 9.92
Hb + S.E	71.6 * ± 28.64	61.5* ± 24.6	66.5* ± 26.60	67.1* ± 26.84	71.3* ± 28.52
Hn + S.E	20.5* ± 8.2	49.7* ± 19.88	31.0* ± 12.4	51.1* ± 20.44	30.7* ± 12.28
H/D	0.00	2.717	2.295	0.00	1.998
	Sulfate (SO_4) contents in leaves dry weight – ppm				
D ± S.E	1478.7* ± 591.2	1351.6* ± 540.64	1211.1* ± 484.4	917.6** ± 367.04	817.6* ± 326.0
H ± S.E	-448.7* ± 179.2	517.6** ± 20.70	610.7* ± 244.1	461.5* ± 184.6	555.1* ± 222.0
E ± S.E	74.8* ± 29.92	56.7** ± 21.70	41.5* ± 16.6	117.5** ± 4.68	712** ± 17.8
Hb + S.E	61.4* ± 24.56	57.1** ± 21.6	60.3* ± 24.12	63.1* ± 25.24	65.5* ± 26.26
Hn + S.E	50.7* ± 20.28	45.7* ± 21.6	44.7* ± 17.60	50.7* ± 20.28	49.5* ± 19.80
H/D	0.00	0.383	0.304	0.503	0.678

D = amount of additive genetic variance H= amount of dominance genetic variance

E = plant to plant environmental variance S.E = Standard error.

Hb and Hn = Heritability in broad narrow sense.

for chemical component traits. Thus selection might be operative for improving such traits under saline condition.

Genetic Parameters of Yield and its Attributes

The relative contribution of additive (D), dominance (H), environmental (E) components and heritability in broad and narrow senses were shown in Table 3. The results revealed that both additive and dominance genetic components were significant for all grain yield and its attributes.

The dominance genetic portion appeared to be the prevailed type controlling number of spikes /plant, number of grains/spike and grain yield /plant. While, the additive genetic component controlled the inheritance of 1000-grain weight. Thus, phenotypic selection could be effective for improving 1000 – grain weight under saline condition .Improving grain yield /plant by hybrid and selection in segregated generation are effective under saline condition. These results are in harmony with those obtained by Hassan and Nahed (2002) and Al-Yassin *et al.* (2005). The average degree of dominance $(H/D)^{05}$ was more than unity in barley grain yield and in most cases for yield attributes.

They environmental variance was significant for all grain yield and some its attributes except the number of spikes/plant. Heraby, these characters were influenced by the environmental conditions

Narrow sense heritability (H_n) was moderate to high for both number of spikes / plant and 1000-grain weight. Whereas it was low to moderate for both number of grains/spike and grain yield / plant. These results are in harmony and agreement with received with those obtained by Sharma and vimal (2000), Afiah *et al.* (2001) Engine *et al.* (2002). Hassan and Nahed (2002), Baghizadeh *et al* (2004) and Al-Yassin (2005).

For improving barley under saline conditions, it could be used some selection criteria related to salt tolerance i.e. Proline, K/Na, Mg, and SO_4 contents as well as number of spikes/plant, number of grain /spike and 1000-grain weight as selection indices to produce new barley genotypes more tolerant to salinity with high productivity of grain yield under saline condition.

Table 3. Additive (D), dominance (H), environmental and heritability in broad and narrow sense of F_3 families for yield and its component of barley crosses plant measured at harvesting

Component	Crosses				
	1	2	3	4	5
	Giza 123×ICARDA-1	Giza 123×ICARDA-2	Giza 123×ICARDA-3	Giza 123×ICARDA-4	Giza 123×ACSAD-5
	Number of Spikes / Plant				
D ± S.E	8.59* ± 3.44	11.81* ± 4.72	39.88* ± 15.95	28.81* ± 11.52	38.74* ± 15.49
H ± S.E	14.88* ± 6.51	18.75* ± 7.50	36.88** ± 14.75	19.98* ± 7.99	47.61** ± 18.86
E ± S.E	2.31* ± 0.94	5.31* ± 2.41	12.51* ± 5.00	10.57* ± 4.28	11.66* ± 4.66
Hb + S.E	50.1* ± 20.61	48.7* ± 19.48	57.1* ± 22.84	53.1* ± 21.24	60.00* ± 24.0
Hn + S.E	39.6* ± 15.84	29.5* ± 11.8	50.7* ± 20.0	33.4** ± 13.36	29.10* ± 11.64
H/D	1.732	1.587	0.925	0.694	1.217
	Number of grains / Spike				
D ± S.E	73.1* ± 29.24	64.6* ± 25.84	45.7 ± 18.28	70.8* ± 28.32	94.81** ± 37.94
H ± S.E	346.0** ± 144.0	171.1** ± 68.4	120*.5 ± 48.2	311.6** ± 124.4	320.1** ± 123.00
E ± S.E	14.7* ± 5.88	30.0** ± 12.0	13.5* ± 5.4	37.0* ± 14.8	30.5* ± 12.20
Hb + S.E	61.5* ± 24.6	55.1* ± 22.55	54.7* ± 21.88	64.7** ± 25.88	71.1** ± 28.44
Hn + S.E	22.7* ± 9.08	36.7* ± 14.68	38.1* ± 15.24	28.8* ± 12.41	31.6* ± 12.64
H/D	4.733	2.655	2.05	4.401	3.376
	1000- grain weight / gm				
D ± S.E	111.7** ± 44.68	42.6* ± 17.04	66.5* ± 26.6	39.8* ± 16.92	28.5* ± 11.4
H ± S.E	251.4** ± 100.4	340.7* ± 136.28	44.5* ± 17.8	31.6* ± 12.64	86.1* ± 11.4
E ± S.E	15.7* ± 6.28	10.4* ± 4.16	12.5* ± 5.0	10.6* ± 4.24	7.3* ± 2.92
Hb + S.E	61.2* ± 24.48	63.4** ± 23.36	70.1* ± 28.08	63.3* ± 25.32	51.3* ± 20.52
Hn + S.E	30.5* ± 12.2	29.8* ± 11.92	50.7* ± 20.28	40.5* ± 16.2	34.1* ± 13.64
H/D	2.251	7.997	0.669	0.794	3.021
	Grain yield / plant (gm)				
D ± S.E	19.7* ± 7.88	10.7* ± 4.28	16.7* ± 6.68	10.31* ± 4.12	15.7* ± 6.28
H ± S.E	38.1* ± 15.24	17.7* ± 7.08	30.1* ± 12.04	63.4** ± 16.91	49.2* ± 19.68
E ± S.E	8.3* ± 3.32	5.7* ± 2.28	8.4* ± 3.36	4.8* ± 1.92	5.3* ± 2.12
Hb + S.E	59.4* ± 23.76	51.3* ± 20.53	56.1* ± 22.44	60.3* ± 24.12	48.1* ± 19.24
Hn + S.E	31.3* ± 12.52	26.3* ± 10.52	30.8* ± 12.32	30.1* ± 12.04	21.7* ± 8.68
H/D	1.949	1.654	1.802	6.149	3.144

D = amount of additive genetic variance H= amount of dominance genetic variance
E = plant to plant environmental variance S.E = Standard error.
Hb and Hn = Heritability in broad narrow sense.

Phenotypic and Genotypic Correlation

The phenotypic (rp) and (rg) correlation coefficients were estimated from individual F_3 plants data of the five barley crosses; Giza-123 × ICARDA 1, Giza-123 × ICARDA-2, Giza-123 x ICARDA-3, Giza-123 × ICARDA 4 and Giza-123 × ACSAD 5. Estimates of (rp) and (rg) between grain yield and leaves chemical contents are presented in Table (4).

Genotypic correlation coefficient was generally higher than their corresponding phenotypic one's, indicating strong inherent associations between grain yield and each of the studied traits. Simple correlation values varied in magnitude and sign of some cases between characters in each F_3 family. This findings are in accordance with those previously obtained by El-Sayed *et al.* (1995), Afiah and Abdel-Hakim (1999), Kattab and Afiah (1999), Afiah *et al.*(2001) and Sundeep and Parsad (2007). The obtained results in Table 2 revealed that grain yield /plant was positively correlated at both phenotypic and genotypic levels with each of proline content, K/Na ratio and Mg contents in most studied F_3 family crosses.

Both phenotypic and genotypic correlation coefficients between yielding ability and Cl content in leaves were significantly negative in all selected F_3 families studied. SO_4 content was positively correlated to grain yield in the F_3 families derived from Giza 123 x ICARDA-4 and Giza 123× ACSAD- 5 crosses. The genotypic association between yielding ability and each of such traits suggesting that genes controlling grain yield / plant are linked with those controlling the correlated traits. The earlier results reported by Afiah *et al.* (2001) are in partial harmony with these findings in barley.

The association between grain yield and its contributing characters measured as phenotypic (rp) and genotypic (rg) correlation coefficients are presented in Table 3. It could be seen from the present data that the inter-relationships among the studied characters under such saline conditions varied in magnitude according to the F_3 population genotypes responded to environment or mean performance of the studied traits. However, in general the genotypic (rg) correlation coefficient was higher than the phenotypic one's. In this respect, previous studies by

Hassan and Abdel-Sabour (1991), Ceccarelli *et al.* (1992), Kattab and Afiah (1999), Afiah *et al.* (2001) as well as Hassan and Nahed (2002), reported that grain yield was positively and significantly associated at the phenotypic and (or) genotypic level with each of number of spikes / plant, number of kernels/ spike, 1000- kernel weight and spike length in barley under varying environments.

Data in Table 5 revealed that spike length had positive and significant simple correlation coefficient values with grain yield /plant in Giza-123× ICARDA-1, Giza-123 × ICARDA-3 and Giza-123 × ACSAD-5 F_3 cross families. Number of spikes/ plant significantly associated with yielding ability in Giza-123× ICARDA-1, Giza-123× ICARDA-4 and Giza-123× ACSAD-5 at both phenotypic and genotypic levels. Number of grains /spike showed the same trend in all F_3 families studied, except that derived from Giza-123× ICARDA-4. The thousand grain weight showed highly significant and positive correlated to grain yield at the two levels (rp and rg) in Giza-123× ICARDA-1, Giza-123× ICARDA-3 and Giza-123 x ACSAD-5 while in Giza-123× ICARDA-4 F_3 family it reached the level of significance at (rg) only (0.524^*). Generally, the interrelationships of grain yield / plant and chemical composition of leaves (at 75 days after sowing) as well as yield component were positive and the significant in most cases except for Cl content which was negatively correlated to grain yield /plant. For improving grain yield under saline conditions, the suitable barley genotypes most be characterized by some traits as heavy grains, high number of grains/spike. Also, the barley genotypes or crosses were moderated content of proline in fresh leaves and low chloride content in dry leaves. These findings are more or less in accordance with those reported by Afiah (1999) and Afiah *et al.* (2001).

Heterotic Effect

Remain heterosis expressed as the percentage deviation of F_2 performance from its mid and better parent values for all traits studied are presented in Table 6. It is worth nothing that heterotic effect was generally more pronounced for grain yield /plant than for any its components. For plant height, two crosses ICARDA-4 × ACSAD-5 and ICARDA-3 x ICARDA-4 expressed significant negative heterotic effects relative to mid and better parent (-14.46 & -8.36) and (-20,35 & -14,46%).

Table 4. Phenotypic (rp) and Genotypic (rg) correlation coefficients between grain yield and each of the yield attributes recorded

Character	Correlation coefficient	F_3 families				
		Giza-123 × ICARDA 1	Giza-123 × ICARDA 2	Giza-123 × ICARDA 3	Giza-123 × ICARDA 4	Giza-123 × ACSAD 5
No. of tillers	Rp	0.514**	0.351*	0.515*	0.333*	0.515**
	rg	0.318*	0.316*	0.500**	0.116	0.444**
Spike length (cm)	Rp	0.872**	0.441	0.676**	0.400	0.612**
	rg	0.588**	0.450	0.717**	0.422	0.622**
No. of spikes/plant +	Rp	0.676**	0.316	0.411	0.500*	0.577*
	rg	0.700**	0.400	0.447	0.510*	0.588*
No. of grains/spike	Rp	0.515*	0.517*	0.518*	0.346	0.512*
	rg	0618**	0.519*	0.545*	0.417	0.534*
1000-grain weight	Rp	0.672**	0.400	0.672**	0.505	0.618**
	rg	0.716**	0.415	0.688**	0.524*	0.622**

*and** Denote significant at 0.05 and 0.01 levels of probability, respectively.

Table 5. Phenotypic (rp) and Genotypic (rg) correlation coefficients between grain yield and yield attributes recorded

Character	Correlation coefficient	F_3 families				
		Giza-123 × ICARDA 1	Giza-123 × ICARDA 2	Giza-123 × ICARDA 3	Giza-123 × ICARDA 4	Giza-123 × ACSAD 5
No. of tillers	rp	0.514**	0.351*	0.515*	0.333*	0.515**
	rg	0.318*	0.316*	0.500**	0.116	0.444**
Spike length (cm)	rp	0.872**	0.441	0.676**	0.400	0.612**
	rg	0.588**	0.450	0.717**	0.422	0.622**
No. of spikes/plant	rp	0.676**	0.316	0.411	0.500*	0.577*
	rg	0.700**	0.400	0.447	0.510*	0.588*
No. of grains/spike	rp	0.515*	0.517*	0.518*	0.346	0.512*
	rg	0618**	0.519*	0.545*	0.417	0.534*
1000-grain weight	rp	0.672**	0.400	0.672**	0.505	0.618**
	rg	0.716**	0.415	0.688**	0.524*	0.622**

*and** Denote significant at 0.05 and 0.01 levels of probability, respectively.

Table 6. Remain heterosis as percentage of F_2 deviation from mid-(MP) and better parent (Bb) for the studied characters

Genotypes		Plant height (cm)	NO. tillers / plant	Spike length (cm)	NO. of grain / Spike	1000-grain weight(g)	Grain yield / plant (g)
$P_1 \times P_2$	MP	18,77**	-23.03**	1.29	-9.81**	18.45**	-6.92
	BP	10,19**	-25.78**	-11.54**	-12.44**	16.49**	-15.88**
$P_1 \times P_3$	MP	3,93	12.65**	-6.55	-5.98	12.85**	16.81**
	BP	-12,24**	10.42	-22.34**	-10.38*8	4.74	4.00
$P_1 \times P_4$	MP	6,68**	45.37**	14.46**	-1.37	18.91**	55.55**
	BP	-11,49**	33.42**	-0.37	-5.49	5.81	45.27**
$P_1 \times P_5$	MP	9,66**	-15.71*	-6.48	2.96	-5.32	5.39
	BP	-3,46	-22.13**	-23.34**	-5.91	-14.26**	-5.12
$P_1 \times P_6$	MP	7,65**	20.44**	8.13*	3.34	10.35**	13.13*
	BP	-5,67**	15.33	3.33	-6.14	4.77	3.33
$P_2 \times P_3$	MP	11,60**	19.96**	-2.40	-5.69	13.85**	21.50**
	BP	0,73	10.98	-7.97*	-7.64	7,66*	19.48**
$P_2 \times P_4$	MP	-2,11	-23.71**	-3.13	16.61**	8.44*	1.74
	BP	-13,32**	-32.88**	-3.66	6.73	-1.85	-3.61
$P_2 \times P_5$	MP	7,60**	15.49*	1.37	11.91**	23.21**	36.74**
	BP	1,65	8.75	-5.39	7.44	12.70**	34.73**
P2 × P6	MP	8.88**	11.44	2.11	11.00**	11.11**	20.21**
	BP	2.14	00.00	-4.44	3.11	4.33	8.33*
P3 × P4	MP	-0,96	16.41*	-7.89**	-21.34**	13.38**	-16.45**
	BP	-3,07	8.75	-14.03	-30.36**	10,64**	-21.64**
P3 × P5	MP	-16,40**	20.21**	-24.68**	-19.55**	-0.33	-3.45
	BP	-20,35**	13.42	-27.52**	-21.36**	-3.64	-3.54
P3 × P6	MP	-14,37**	14.11	-10.11**	-17.77**	1.13	-5.00
	BP	-2.46**	7.43	-19.19**	-24.33**	-2.99	-8.88*
P4 × P5	MP	-8,36**	-14.26**	8.38**	-10.42**	-14.13**	-31.01**
	BP	-14,46**	-15.50**	0.66	-20.34**	-14.85**	-31.00**
P4 × P6	MP	-10.56**	9.88	9.99**	-8.35*	7.99*	19.03**
	BP	-7.33**	-1.33	-0.03	-19.33**	-0.22	-1.14
P5 × P6	MP	10.55**	15.44*	7.37*	-30.44**	11.11**	-18.18**
	BP	-1.37	-3.89	1.12	-19.00**	-1.33	-21.33**

respectively While, the crosses Giza 123 x ICARDA- 2; Giza 123 x ICARDA-3 and ICARDA- 1 x ICARDA- 3 exhibited significant negative heterotic effects relative to better parent value. However, the crosses Giza 123 x ICARDA-1, Giza- 123 ICARDA- 3; Giza 123 x ICARDA- 4, ICARDA-1 x ICARDA-2 and Giza 123 x ICARDA-3 showed significantly positive heterotic effects relative to mid-parent value. El-Marakby *et al.* (1993);Afiah and Abdel-Hakim (1999); Budak (2000) and Sharma *et al.* (2002) reported that tall barley hybrids would be susceptible to lodging when yield are maximized by the use of irrigation and heavy applications of fertilizers. Significant positive heterotic effect relative to the taller parent values was reached by Afiah *et al.* (2001) and El-Sayed *et al.* (2007). On the other hand, Baghizadeh *et al.* (2004) found no heterotic effects for the trait over the taller parent.

With respect to number of tillers/plant, six crosses exhibited significantly positive heterotic effects relative to mid-parent value ranging from 12.65% (Giza 123 x ICARDA- 2) to 45.37% (Giza 123 x ICARDA- 3). While, significant positive heterotic effect relative to better parent was observed in one cross Giza 123 x ICARDA-3 (35.42%). In this respect, Sharma and Vimal (2000) and Sundeep and Prasad (2002) found significant positive heterosis. Meanwhile Saad *et al.* (2005) found insignificant heterotic effect for such trait. For spike length, two crosses expressed positive and significant heterotic effects relative to mid- parent value, Giza 123 x ICARDA-3 (14.46%) and ICARDA-3 x ICARDA-4 (8.38%). However, the other crosses exhibited significantly negative or insignificant heterotic effects relative to mid and/or better parent value. Heterotic effects were previously found by El-Sayed (1997); Afiah and Abdel-Hakim (1999) and El-Sayed *et al.* (2007).

With regard to number of grain/spike, significantly positive heterosis relative to mid-parent was observed in two crosses, VIZ. ICARDA- 1 x ICARDA- 3 (16.61%) and ICARDA- 1 x ICARDA- 4 (11.91%). The other crosses showed either significantly negative or insignificant heterotic effects relative to mid or better parent value. Similar results were found by Ahmed (1998); Budak 2000; Engin *et al.* (2000) and Sharma *et al.* (2002).

For 1000-grain weight, seven crosses expressed significantly positive heterotic effects relative to mid-parent and four of these crosses exhibited significantly positive heterotic effects relative to better parent ranging from 7.66% (ICARDA- 1 x ICARDA- 2) to 16.49 % (Giza 123 x ICARDA-1) Sparza *et al.* (1996), Sharma *et al.* (2002) Saad *et al.* (2005) and El-Sayed *et al.* (2007) reported that most F_1 and /or F_2 hybrids exhibited significant positive heterotic effect for 1000-grain weight. Concerning grain yield /plant, the three crosses Giza-123 x ICARDA- 2, Giza-123 x ICARDA- 3 and Giza- 123 x ICARDA-4 significantly exceeded these respective mid or better parent, ranging from 21.5 to 55.55 and 36.74 to 34.74%, respectively. This result indicate accumulation of increasing alleles of barley grain yield. These F_2 hybrids exhibited significantly heterosis for one or more of traits contributing grain yield. It could be concluded that these crosses would be efficient and prospective in barley breeding programs for improving grain yield/plant. Significant positive heterosis for grain yield / plant was reached by El- Hennawy (1991). El-Marakby *et al* (1993); Afiah and Abdel-Hakim (1999); Budak (2000); Afiah *et al.* (2001); Sharma *et al.* (2002), Saad *et al.* (2005) and El-Sayed *et al.* (2007).

From the above mentioned results, It could be concluded that considerable positive heterosis relative to mid or better parent was exhibited for the most studied characters and maximum heterosis relative to mid-parent was observed for grain yield/plant in (Giza-123 x ICARDA-3) followed by number of spikes/plant in (Giza- 123 x ICARDA-3) and number of grains/spike in (Giza-123 x ACSAD-5) with values of 55.55, 45.37 and 16.61%, respectively.

Path Coefficient Analysis

The direct and joint effects of chemical contents in leaves in Table 7 for five F_3 selected families measured as genotypic variations to grain yield / plant are presented in Table 7.The highest direct effect was exerted by proline content followed by SO_4 content in most F_3 studied families. Regarding the indirect effects on grain yield variations was recorded for, proline via Mg, Mg via SO_4 over all F_3 populations. It is evident to mention that, the studied chemical contents accounted by

Table 7. Direct and joint effects of studied leaves chemicals contents for some F_3 families of barley measured as genotypic variation to grain yield / plant

Source of variation	Genotypic coefficient of determination (CD)				
	G123 x ICARDA-1	G123 x ICARDA-2	G123 x ICARDA-3	G123 x ICARDA-4	G123 x ACSAD-5
Proline	0.0515	0.0392	0.9411	0.0511	0.0671
K / Na ratio	0.0154	0.0201	0.0341	0.0491	0.0161
Mg content	0.0162	0.0273	0.0356	0.0314	0.0261
Cl content	-0.0167	-0.0199	-0.0248	-0.0317	-0.0417
SO4 content	0.1315	0.0175	0.0245	0.0316	0.0384
Proline × K/ Na	0.0416	0.0715	0.0551	0.0466	0.0688
Proline × Mg	0.0478	0.0765	0.0651	0.0877	0.0576
Proline × Cl	0.0352	0.0215	0.0446	0.0581	0.0682
Proline × SO_4	0.1116	0.0417	0.0561	0.0381	0.0777
K / Na × Mg	0.0342	0.0315	0.0444	0.0441	0.0576
K / Na × Cl	0.0194	0.0182	0.0244	0.0314	0.0781
K /Na × SO_4	0.0518	0.0679	0.0748	0.0615	0.0419
Mg × Cl	0.0352	0.0517	0.0648	0.0716	0.0781
Mg × SO_4	0.0810	0.0752	0.0848	0.0662	0.0542
Cl × SO_4	0.0454	0.0432	0.0916	0.0887	0.0772
R^2	0.7008	0.5825	0.7163	0.7256	0.7756
Resudial	0.2992	0.4175	0.2837	0.2744	0.2244
Total	1.0000	1.0000	1.0000	1.0000	1.0000
<u>Total Contribution %</u>					
Proline	16.95	14.48	15.16	16.64	20.33
K /Na ratio	8.89	11.45	13.35	14.09	14.29
Mg content	11.52	14.47	16.51	16.62	15.14
Cl content	5.09	4.73	8.80	9.32	10.91
SO_4 content	27.64	13.12	17.81	15.89	16.90

70, 58.3, 71.6, 72.5 and 77.6 of the total grain yield variations for the F_3 families derived from Giza-123× ICARDA-1, Giza-123× ICARDA-2, Giza-123× ICARDA-3, Giza-123× ICARDA-4, and Giza-123× ACSAD-5 barley crosses respectively. The total contribution of each chemical components in leaves showed that proline content was the most powerful determinant of grain yield in Giza-123 × ACSAD-5 F_3 family as it contributed by 20.33%. In general, the basis of total contribution of the determined chemical contents could be arranged over all studied F_3 populations as follows: SO_4, Proline, Mg, K/Na and Cl contents.

Table 8 presented the direct and joint effects of studied yield attributes for the selected F_3 families measured as genotypic variations to grain yield /plant. All sources of yield variations were positive whereas, largest contribution was detected for number of tillers/plant in most of the studied F_3 families as direct effect. The indirect (joint) effects of different characters recorded towards grain yield revealed that spike length via 1000-grain weight, number of tillers/ plant via number of grains/ spike, number of tiller /plant via plant height and number of grains /spike via 1000-grain weight had an important positive effects in two or more of the studied F_3 families. Total contribution percentages showed that the main source of grain yield variation was 1000- grain weight followed by number of grains /spike and number of spikes /plant in three or more of the F_3 families. Such highly contributed trait easily measured and gave a valuable idea for the selection to yield improvement under saline environments. Earlier published by El-Sayed *et al.* (1995); Afiah and Abdel-Hakim (1999), Sundeep and Prasad (2002) and Baghizadeh *et al.* (2004) mentioned that all the selected characters for chemical contents in leaves and yield components were considered as important selection criteria for improving barley under saline conditions.

Table 8. Direct and joint effects of studied yield attributes for some F_3 families of barley measured as genotypic variation to grain yield / plant

Source of variation	Genotypic coefficient of determination (CD)				
	Giza-123 × ICARDA-1	Giza-123 × ICARDA2	Giza-123 × ICARDA-3	G123 × ICARDA-4	G123 × ACSAD5
Plant height (cm)	0.0016	0.0467	0.0833	0.0981	0.0572
No. of tillers / plant	0.0600	0.0761	0.0517	0.0457	0.0615
Spike length (cm)	0.0603	0.0476	0.0416	0.0335	0.0333
No. of grains / spike	0.0268	0.0417	0.0416	0.0517	0.0482
1000-grain weight (gm)	0.0442	0.0403	0.0918	0.0817	0.0611
Plant height × No. of tillers/ plant	0.0027	0.0241	0.0715	0.0716	0.0711
Plant height × spike length	0.0518	0.0710	0.0417	0.0472	0.0476
Plant height × No. of grain / spike	0.0015	0.0512	0.0512	0.0517	0.0617
Plant height×1000-grain weight	0.0266	0.0517	0.0418	0.0642	0.0571
No. of tillers/plant × Spike length	0.1092	0.0512	0.0515	0.0572	0.0476
No. of tillers × No. of grains / spike	0.0512	0.0511	0.0676	0.0511	0.0617
No. of tillers × 1000- grain weight	0.0072	0.1000	0.0572	0.0541	0.0571
Spike length × No. of grains / spike	0.0108	0.0612	0.0417	0.0531	0.0511
Spike length × 1000-grain weight	0.1111	0.0981	0.0531	0.0416	0.0551
No. of grains /spike × 1000-grain weight	0.0451	0.0617	0.0417	0.0810	0.0717
R^2	0.9489	0.8737	0.8443	0.8934	0.8844
Resudial	0.0511	0.1263	0.1557	0.1065	0.1156
Total	1.0000	1.0000	1.0000	1.0000	1.0000
Total Contribution %					
Plant height (cm)	4.28	19.57	19.41	21.54	17.59
No. of tillers/ plant	14.51	18.93	17.56	18.77	18,02
Spike length (cm)	25.04	14.38	13.55	13.30	13.40
No. of grains / spike	37.14	15.42	14.76	17.01	17.22
1000-grain weight (gm).	13.92	19.07	19.14	20.72	18.16

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تقدير المؤشرات الوراثية والارتباط ومعامل المرور لبعض عائلات الجيل الثالث من الشعير تحت ظروف الملوحة

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تهدف هذه الدراسة إلي تقييم بعض العائلات المنتخبة في هجن الجيل الثالث لنباتات الشعير تحت ظروف الري بمياه ذات ملوحة تتدرج من ٩٠٠٠ وحتى ١١٠٠٠ جزء في المليون خلال مواسم النمو٢٠٠٢ / ٢٠٠٣ وحتى ٢٠٠٤/ ٢٠٠٥. حيث تم اخذ عينة عشوائية من أوراق عشر نباتات لكل عائلة من عائلات الهجن الخمسة المختارة بعد ٧٥ يوم من الزراعة لتقدير نسبة البرولين ونسبة البوتاسيوم إلي الصوديوم والماغنسيوم والكلوريد الكبريتات كما تم تسجيل بيانات خمسة عشر نباتاً منتخباً من كل مكررة عند الحصاد لصفات عدد سنابل النبات – طول السنبلة – عدد حبوب السنبلة – وزن ١٠٠٠ حبة، ومحصول الحبوب للنبات.

وقد تم تقدير المؤشرات الوراثية ودرجة التوريث ومعامل الارتباط ومعامل المرور لبيانات كل عائلة منتخبة علي حدة ويمكن تلخيص أهم النتائج في الآتي:

أشارت النتائج أن المكون الوراثي المضيف قد لعب دورا أساسيا في التحكم في محتوى الأوراق من الكبريتات ونسبة البوتاسيوم إلي الصوديوم في حين أن المكون الوراثي السيادي كان هو المتحكم في محتوى الوراق من البرولين والماغنسيوم تحت ظروف الملوحة وكانت درجة التوريث في المعني الواسع عالية، بينما كانت متوسطة بالمعني الضيق لجميع الصفات المدروسة لمحتوى الأوراق الكيماوي.بينما كان التباين البيئي معنوي لكل الصفات تحت الدراسة من محتوى الأوراق مما يشير إلي أهمية الانتخاب في هذه الحالات. بالمثل كان المكون الوراثي السيادي هو المتحكم في معظم صفات المحصول تحت الدراسة ما عدا وزن الألف حبة حيث كان المكون الوراثي المضيف هو المتحكم في توريث الصفة، أما بالنسبة لدرجة التوريث فكانت متوسطة إلي عالية بالمعنى الواسع لكل الصفات في حين كانت متوسطة إلي منخفضة بالمعنى الضيق لكل الصفات المدروسة وكان تأثير التباين البيئي واضحا بشدة على صفة عدد حبوب السنبلة للنبات مما يؤكد على ضرورة الاستمرار في عملية الانتخاب. بالنسبة للمكونات الكيميائية في عينات أوراق النبات بعد ٧٥ يوم من الزراعة وكذلك الصفات المساهمة في محصول حبوب النبات كانت معاملات الارتباط بينها وبين الكفاءة المحصولية موجبة ومعنوية في معظم الحالات ما عدا محتوى الأوراق من الكلوريد كانت سالبة في جميع الحالات. كما أمكن توصيف التركيب الوراثي من الشعير المناسب للزراعة تحت مثل هذه الظروف الملحية بصفات كبر حجم الحبوب وزيادة عددها في السنبلة مع انخفاض محتوى الأوراق من الكلوريد. تباينت قيم معامل التوريث عبر الصفات المدروسة وبين عشائر الجيل الثالث المنتخبة وعليه فيمكن تحسين المحصول من خلال الصفات الأكثر مساهمة بعد تحليل معامل المرور .بدراسة مجموع المساهمات الكلية (مباشرة وغير مباشرة) لمكونات الأوراق الكيميائية كان المحتوى من البرولين من أقوى محددات المحصول في عشيرة الجيل الثالث المنتخبة من انعزالات الهجين جيزة١٢٣ × أكساد ٥ حيث ساهم ٢٠,٣٣ % ولكن بنظرة عامة إلي كافة العشائر تحت الدراسة يمكن ترتيب المكونات الكيميائية حسب درجة مساهمتها في محصول الحبوب علي النحو التالي : نسبة الكبريتات يليها البرولين ثم والماغنسيوم ثم نسبة البوتاسيوم إلي الصوديوم (K/Na) وأخيراً الكلوريد. كان المكون الرئيسي في اختلافات محصول النبات من الحبوب هو وزن ١٠٠٠ حبة متبوعاً بعدد حبوب السنبلة ثم عدد سنابل النبات في ثلاثة أو أكثر من عائلات الجيل الثالث تحت الدراسة وعليه يمكن اعتبار هذه الصفات سهلة القياس من الدلائل الانتخابية الهامة لتحسين المحصول تحت الظروف الملحية. ويمكن الاعتماد على صفات نسبة البوتاسيوم إلي الصوديوم ومحتوى الأوراق من الكبريتات والبرولين وكذلك عدد سنابل النبات وعدد حبوب السنبلة وطول السنبلة ووزن الألف حبة ومحصول الحبوب للنبات كأدلة انتخابية في الأجيال الانعزالية لعائلات هجن الشعير تحت ظروف الملوحة.