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Screening Wheat and Barley Genotypes for Salinity Resistance

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Abstract: To screen wheat and barley genotypes for salinity resistant, 10 bread wheat, 12 durum wheat and 11 barley genotypes were planted under saline conditions. Salinity was ranged (20.6-21.9 and 4.5-5.5 dS m^{-1}) for both soil and water, respectively. Wheat genotypes Jumaizah, Bin-bashair and Snap and barley genotypes Acsad 176, line 5 and Rum showed high biological yield Performance. Genotypes: Jumaizah, Bin-bashair, Snap, Cham3 and Cham6 and barley genotypes: line3, line2 and line5 showed high seed yield performance. However wheat genotypes Behowth1 exhibited the highest straw yield performance compared to other wheat genotypes. Germination percentage has a strong positive correlation with seed yield (0.75) and straw yield (0.41). Negative association between heading and physiological maturity periods with seed yield (-0.29) for each was obtained. Concerning wheat and barley genotypes nitrogen (N) content at the three leaf stage was negatively correlated (-0.19) with seed yield compared to the elongation stage, while, Potassium (K) and K/Na ratio showed a strong positive correlation at the tree leaf stage (0.21 and 0.22), respectively. In wheat genotypes Potassium (K) content, (K/Na) and Sodium (Na) have showed a strong positive correlation with seed yield in wheat genotypes (0.26, 0.29 and 0.30), respectively whereas, chloride (CL) showed a strong negative correlation (-0.26) with the seed yield. In barley genotypes, P and K have a strong negative correlation with the biological yield (-0.42 and -0.39), respectively and with the straw yield (-0.47 and -0.49), respectively at the three leaf stage. Sodium (Na) (-0.39) has the same trend like P and K but at the elongation stage. It is clear that leaf analysis at the 3-leaf stage is more indicative to reveal salinity resistance in both wheat and barley genotypes compared to the advanced growth stages. K/Na ratio could be used as selection criteria for salinity resistance because it is highly correlated with biological, seed and straw yields in both wheat and barley genotypes. Bread wheat genotypes: Jumaizah and Cham6, durum wheat genotypes: Bin-bashair, Cham3 and Snap and barley genotypes: Line5, Accsad176 and Rum are selected as salinity resistant genotypes.

Key words: Salinity resistant, germination percentage, germination period, heading period, physiological maturity period, biological yield, seed yield, straw yield

INTRODUCTION

Wheat and barley are the most important field crops in Jordan with annual average production during the last decade of 46823 and 35973 metric tons, respectively (FAO, 2002). Saline areas with salinity levels grater than 12 dS m^{-1} comprised 18.6% of the total irrigated area in Jordan valley (Jordan Valley Authority-Project of Soil Classification, 1989). Salinity is increasingly limiting the production of graminaceous crops constituting the main sources of staple food (rice, wheat, barley, maize and sorghum), primarily through reductions in the expansion and photosynthetic yield of the leaves. Cropping on saline land is restricted by the low tolerance of crops to salinity. Prospects for improving salt tolerance in wheat and barley include the use of: (i) intra-specific variation, (ii) variation for salt tolerance in the progenitors of these cereals, (iii) wide-hybridization with halophytic 'wild' relatives (an option for wheat, but not barley) and(iv) transgenic techniques (Colmer *et al.*, 2005). Growth response of wheat and barley genotypes to salinity has two phases. In the first phase there would be a large decrease in growth rate caused by the salt outside the roots. In the second phase there would be an additional decline in growth caused by salt having built up to toxic levels within plants (Munns *et al.*, 1995). Salinity resistant varieties selected in India produced (4.5 t ha^{-1}) as compared to sensitive ones (2.5 t ha^{-1})

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(Nagvi and Tadon, 1991). A reduction of 24-30% in the yield of salinity tolerant wheat varieties occurred when exposed to 8-12 dSm^{-1} salinity level (Change and Sipio, 1991). Shalaby *et al.* (1991) found that varieties derived from the salinity resistant variety Sakha8 are resistant to salinity. But higher salinity affected germination percentage, delayed germination, root weight and biological yield. Boubaker (1996) found that increasing salinity reduced germination percentage, coleoptiles length number of roots, root length, first leaf length and plant height as compared to control. He suggested that these characters could be used as a standard measures for selection of salinity resistant genotypes in the seedling stage. Rawson *et al.* (1988) screened 20 genotypes of barley, wheat, durum wheat and triticale; he found that large area of seedling leaves is a good indicator of high absolute salinity tolerance. Cl^- concentration also was a poor indicator of productivity under salinity. Maas *et al.* (1994) found that salinity reduced number of tillers/plant in two spring wheat; he suggested increasing plant spacing in saline soil to give opportunity for tillers to develop and grow. Shaviv *et al.* (1990) found that salinity reduced total dry weight, total (N) and total (P) contents in grains for several wheat genotypes. Concentration of (Cl and Na) in plant tissue increased with increase in salinity. El-Hendawy *et al.* (2005) conclude that Na^+ and Cl^- exclusion did not always reflect the salt tolerance, whereas K^+ in the leaves and Ca^{2+} in the leaves and stems were closely associated with genotypic differences in salt tolerance among the 13 genotypes studied. Calcium content showed a greater difference in salt tolerance among the genotypes than did K^+ content. Dell and Spada (1992) showed that durum wheat seeds that soaked in saline solution reduced water imbibitions and protein synthesis in the roots at the seedling stage as compared to the control. Salam *et al.* (1992) studied the effect of salinity on sensitive and resistant wheat varieties and their F1generation; he found that sensitive varieties have accumulated higher quantities of Cl and Na in their leaves and their (F1) offspring followed their parents, in this characters. Also he found a strong negative correlation between Cl and Na levels in leaves and the decrease in seed yield. Whereas, K/Na has a strong positive correlation with yields and yield components in the resistant varieties. He concluded that salinity resistant is under the genetic control. Zsoldos *et al.* (1990) conducted a hydroponics study on several wheat genotypes. He found that by increasing salinity (1-10 dS m^{-1}) the concentration of Cl and Na increased in the plant tissue. Also resistant varieties accumulated more (Cl and Na) quantities in their root than in leaves. Li and Lui (1993) found that Na/K was the lowest in resistant wheat varieties as compared to the sensitive ones. They concluded that salinity resistance is associated with the higher selectivity of the plant to absorb K as compared to Na absorption Chhipa and Lal (1995) Na/K ratios of salt tolerant and susceptible varieties of wheat were measured. The Na/K ratio in wheat grain and straw indicate the tolerance of wheat to salinity. The limit of the Na/K ratio of grain and straw of wheat for designating a variety as tolerant is <0.15 and <0.4, respectively while this ratio at, the tillering stage is 0.5.

The low Na^+ durum wheat genotypes showed much longer chlorophyll retention than the high Na^+ genotypes. At ear emergence, the effects of salinity on biomass were less on the low Na^+ than on the high Na^+ genotypes at 75 mM NaCl. At maturity, salinity had a similar effect on biomass of both genotypes. The greater yield of the low Na^+ genotype was due to enhanced grain number and grain weight in the tiller ears. Rivelli *et al.* (2002) found that exposure of four wheat genotypes with contrasting degrees of Na^+ to salt; biomass was reduced in all genotypes to extent (about 50%). Husain *et al.* (2005) found that in the low-Na^+ genotypes, osmotic adjustment depended on higher K^+ and high organic solute accumulation. Stomata conductance of all genotypes was reduced by saline conditions, but the reduction was greater in the low-Na^+ genotypes. These data indicate that selecting lines with low Na^+ accumulation for the purpose of improving salt tolerance is unlikely to introduce limitations for osmotic adjustment. Durum wheat (AB genomes) is more salt-sensitive than bread wheat (ABD genomes). Salt tolerance in bread wheat is linked with a locus on the D genome that results in low Na^+ uptake and enhanced K^+/Na^+ discrimination. Selections for low Na^+ uptake and enhanced K^+/Na^+ discrimination in seedlings grown in 150 mM NaCl resulting in improving salt tolerance in durum wheat breeding programs. The objective of this study is to screen out resistant varieties of wheat and barley that suits to saline areas in Jordan (Munns *et al.*, 1999).

MATERIALS AND METHODS

Genotypes: Twenty two wheat varieties (10 bread and 12 durum) and (11) varieties of barley were planted in Mafraq (Table 1 and 2) during the growing season 2005.

Soil analysis: Eighteen soil samples were taken at two soil depths (0-30 and 30-60 cm). Results of soil analysis revealed that soil salinity at 0-30 cm ranged 9.8-21.9 dS m^{-1}.

Table 1: Wheat varieties used for salinity screening during the growing season 2004

Type	Source	Genotype	Notes
Durum	Jordan	Amra	Local variety
	Jordan	Cham1	Local variety
	Jordan	Deiralla 6 W-A	Local variety
	Jordan	Petra	Local variety
	Syria-ICARDA	Yav79	Breeder seed
	Syria- research center	Vee/s/nav	Breeder seed
	Syria-research center	Snap/s/	Breeder seed
	Syria- research center	Cham3	Local variety
	Syria- research center	Cham5	Local variety
	Syria-research center	Bohouth1	Breeder seed
	Syria-research center	Bohouth5	Breeder seed
	Tunis	Bin bashair	Local variety
Bread	Jordan	Jubeiha	Local variety
	Egypt	Sakha8	Local variety
	Egypt	Sakha92	Local variety
	Egypt	Sids6	Local variety
	Egypt	Sids7	Local variety
	Egypt	Jomaizah	Local variety
	Syria-ICARDA	Cham4	Local variety
	Syria-ICARDA	Cham6	Local variety
	Syria-research center	Bohouth4	Breeder seed
	Syria-research center	Bohouth6	Breeder seed

Table 2: Barley varieties used for salinity screening during the growing season 2004

Genotype	Pedigree	Source	Notes
Local 345	m-all-73-337-1 (ICARDA)	Syria-ICARDA	Breeder seed
Local 75	Mja?s?(ICARDA)	Syria-ICARDA	Breeder seed
Local 375	Lignee527/rihane (ICARDA)	Syria-ICARDA	Breeder seed
Local 120	Gloriallsllcopal (s) (ICARDA)	Syria-ICARDA	Breeder seed
ICARDA8	USA(ICARDA)	America	Breeder seed
ICARDA51	Famesh(ICARDA)	Syria-ICARDA	Breeder seed
ICARDA382	Syria-ICARDA (ICARDA)	Syria-ICARDA	Breeder seed
ICARDA378	Syria-ICARDA	Syria-ICARDA	Breeder seed
ICARDA81	USA(ICARDA)	America	Breeder seed
Accsad176	Jordan	Jordan- local	Local variety
Rum	Jordan	Jordan- local	Local variety

Water analysis: Water sampling were taken monthly during the growing season. Results of water analysis showed that water salinity was 4.5-5.5 dS m^{-1}.

Statistical analysis: The design of experiment is RCBD with three replications. Experimental plot area = 10 m^2 (10 rows of 5 m length, each apart 0.2 m).

Plant analysis: One hundred ninety eight leaf samples were taken once at three leafs stage and once on the elongation stage. Leaf analysis for the contents of the minerals (Cl, Na, Mg, Ca, K, P and N) was conducted in the laboratory.

Characters studied: The following characters were studied: biological yield, seed yield and straw yield, heading period, physiological maturity period and germination percentage.

RESULTS AND DISCUSSION

Concerning germination percentage under saline conditions (Table 3) wheat variety (snap) and barley (line2) showed the highest percentage (90.7%) which is significantly different than wheat variety Sids7 (76%) and Deiralla W-A (76.7%) and insignificantly different with other varieties. The low germination percentage in all genotypes indicates the effect of the higher level of salinity, this agreed with the results obtained by Shalaby *et al.* (1991) and Boubaker (1996). Whereas, in the germination period the wheat varieties: Cham3, Cham5, Bohouth5, Sids6, Sids7 and Deiralla6 W-A showed a long period (14 days) with significant differences compared to wheat varieties Amra and Jubeiha and to all barley varieties except line3. All barley varieties achieved shorter period for germination than wheat varieties, this general delay in germination confirmed the results of Shalaby *et al.* (1991) and Boubaker (1996). For heading date the wheat variety Deiralla6 W-A was the latest (126 days) with a no significant differences with wheat varieties: Amra, Bohouth5 and Bohouth1 and with significant differences with the rest of wheat and barley varieties. In physiological maturity wheat variety Vee was the latest (158 days) with insignificant difference with the wheat varieties: Cham5, Cham6, Bohouth1, Bohouth4, Bin bashair, Amraand Deiralla6 W-A. And with a significant differences with the rest of varieties.

Concerning yield and yield component (Table 4): wheat varieties: Jumaizah, Bin bashair, Cham3, Cham6 and Snap and barley varieties: Line3, Line2, Line5 and Rum showed higher seed yields with significant differences with: Cham4, Bohouth1, Bohouth4, Bohouth5, Sids7, Amra, Petra, Deiralla6 W-A and Lines (6-9). In straw yield, wheat variety Bohouth1 revealed higher yield with a significant differences with: Cham1, Cham5, Sakha92, Amra, Sids6, Sids7, Line3 and Line8 and with insignificant differences with other varieties. In the biological yield wheat varieties Jumaizah, Bin-bashair and snap and barley varieties Line5, Accsad176 and Rum exhibited a significant differences with Sids6 and Sids7 and insignificant differences with the other ones. Looking at the yield and yield component characters the bread wheat genotypes Jumaizah and Cham6 and the durum wheat genotypes Bin-bashair and Cham3 and the barley genotypes Line5, Accsad176 and Rum are the highest yielding potential genotypes under saline conditions.

A significant positive association between germination percentage and seed yield (0.75) and straw yield (0.41) in both wheat and barley genotypes at 0.01 probability level has occurred (Table 5). The effect of salinity is very high on the germination percentage and

Table 3: Germination (%), germination, heading and physiological maturity periods (day) for different wheat and barley screened for salinity during the season 2004

Variety	Germination (%)	Germination	Heading	Physiological maturity
		period (day)		
Cham1	[A],89.3ab	13.0a-d	118.7e-I	153.7e-h
Cham3	90.3ab	14.0a	117.7f-j	152.0g-j
Cham4	90.0ab	13.7ab	119.0d-h	152.0g-j
Cham5	78.3a-d	14.0a	117.0g-j	156.0a-d
Cham6	88.0a-d	12.3cd	120.0c-g	156.0a-d
Bohouth1	86.7a-c	13.3a-c	123.3ab	156.3a-c
Bohouth4	89.0a-c	13.0a-d	122.0b-d	156.0a-d
Bohouth5	78.0b-d	14.0a	123.3ab	155.7b-e
Bohouth6	83.7a-d	13.3a-c	118.3e-I	152.0g-j
Sakha8	87.0a-d	13.0a-d	119.7c-g	154.0d-g
Sakha92	84.3a-d	13.0a-d	121.0b-e	154.0d-g
Sids6	78.3a-d	14.0a	115.0jk	151.3i-g
Sids7	76.0d	14.0a	115.0jk	151.7h-j
Jomaizah	85.0a-d	13.7ab	120.7b-f	152.7f-I
Bin bashair	83.7a-d	13.7ab	121.0b-e	156.0a-g
Jubeiha	85.0a-d	12.7b-d	115.7i-k	153.3f-I
Amra	83.7a-d	12.7b-d	123.3ab	156.7ab
Petra	80.0a-d	13.7ab	117.7f-j	154.3c-f
Deiralla 6W-A	76.7cd	14.0a	126.0a	157.7ab
Snap	90.7a	13.3a-c	123.3bc	154.0d-g
Vee	87.0a-d	13.3a-c	113.7k	185.0a
Yav79	87.0a-d	13.3a-c	116.3h-k	152.0g-j
Line1	89.0a-c	12.0d	107.0p	140.3q
Line2	90.7a	13.3a-c	103.7n-p	141.0pq
Line3	89.7ab	13.0a-d	103.7-p	143.0n-p
Line4	84.0a-d	12.7b-d	108.7lm	148.0kl
Line5	86.7a-d	12.7 b-d	107.3lm	146.0lm
Line6	88.3a-d	12.0 d	107.0lm	144.0m-o
Line7	83.7a-d	12.7 b-d	107.7lm	140.3q
Line8	79.7a-d	12.3 cd	102..9op	140.7q
Line9	80.7a-d	12.7b-d	109.0l	150.0jk
Accsad176	86.0a-d	12.7b-d	106.3lm	142.0o-q
Rum	87.0a-d	12.0d	105.7m-o	141.0pq
LSD (0.05)	8.9	5.9	1.7	0.9
CV (%)	12.34	1.263	3.156	2.212

[A], Means with the same letter(s) within the column are not significantly different at 5% probability level

Table 4: Biologicalyield (t ha^{-1}) Seed yield (t ha^{-1}) and Straw yield (t ha^{-1}) for different wheat and barley screened for salinity during the season 2004

Genotype	Biological yield	Seed yield	Straw yield
		(t ha^{-1})	
Cham1	[A],17.0a-d	4.0a-g	12.8cd
Cham3	18.7a-d	4.3a-f	14.4a-d
Cham4	17.8a-d	3.0f-j	14.8a-c
Cham5	16.5a-d	3.6a-h	13.2b-d
Cham6	19.0a-c	4.3a-f	14.5a-d
Bohouth1	19.0a-c	1.5j	17.9a
Bohouth4	19.2ab	3.3c-I	15.9a-c
Bohouth5	19.6a	2.2h-j	17.4ab
Bohouth6	17.6a-d	4.2a-f	13.4a-d
Sakha8	17.8a-d	4.1a-f	13.6a-d
Sakha92	17.0a-d	3.8a-g	13.2b-d
Sids6	13.9cd	3.9a-g	10.0d
Sids7	12.8d	3.1e-I	10.0d
Jomaizah	20.9a	5.0a	15.9a-c
Bin bashair	20.0a	4.5a-d	15.4a-c
Jubeiha	17.8a-d	3.9a-g	13.9a-d
Amra	14.3b-d	2.3h-j	12.4cd
Petra	17.0a-d	3.2d-I	13.8a-d
Deiralla6 W-A	15.9a-d	2.1ij	13.6a-d
Snap	20.0a	4.2a-f	15.8a-c
Vee	17.8a-d	3.2d-I	14.5a-d
Yav79	17.6a-d	4.3a-f	13.3a-d
Line1	19.2ab	4.5a-e	14.7a-c
Line 2	18.1a-c	4.8ab	13.3a-d
Line3	17.6a-d	4.9ab	12.7cd
Line 4	17.8a-d	4.0a-g	13.8a-d
Line 5	19.8a	4.8ab	15.0a-c
Line6	16.1a-d	2.6g-j	13.5a-d
Line 7	17.1a-d	3.1d-I	14.0a-d
Line 8	15.7a-d	3.5b-I	12.2cd
Line 9	16.1a-d	2.3h-j	13.8a-d
Accsad176	20.0a	4.0a-g	16.0a-c
Rum	19.6a	4.7a-c	14.9a-c
LSD (0.05)	5.221	1.465	4.599
CV (%)	18.1	24.5	20.1

[A], Means with the same letter(s) within the column are not significantly, different at 5% probability level

this one is highly correlated with the seed and straw yields and this agree with result obtained by Nagvi and Tadon (1991), Change and Sipio (1991), Shalaby *et al.* (1991) and Shaviv *et al.* (1990). Whereas, physiological maturity and heading periods are highly correlated with a significant negative correlation to seed yield (-0.29) for each character at 0.01 probability level. It is clear that early heading and early physiological maturity is associated with high seed yield but not with straw yield. However, germination percentage is strongly associated with both yield components (seed and straw) under saline conditions.

In wheat and barley genotypes nitrogen element (N) is negatively correlated with a significant difference with seed yield at the three leaf stage compared to the elongation stage at 0.05 probability level (Table 6). However, phosphorous (P) has not exhibit any significant correlation with the yield and yield components in both wheat and barley in both stages. Potassium (K) and K/Na ratio showed a strong positive correlation with the seed yield at the tree leaf stage (0.21 and 0.22), respectively this confirmed the results obtained by (Salam *et al.* (1992), Li and Lui (1993), El-Hendawy *et al.* (2005), Salam *et al.* (1992), Chhipa and Lal. (1995) and Munns *et al.* (1999).

Table 5: Correlation (r) between germination (%), germination, heading and physiological maturity periods (day) and Yield (t ha^{-1}) for different wheat and barley screened for salinity during the season 2004

Yield (t ha^{-1})	Germination (%)	Germination	Heading	Physiological maturity
		period (day)		
Seed	[A,B], 0.75[B]	-0.17	-0.29[B]	-0.29[B]
Straw	0.41[B]	0.12	0.10	0.06

[A], significant at 5% probability level [B], significant at 1% probability level

Table 6: Correlation (r) between minerals content (N, P, K, Na, Ca, Mg, Cl and K/Na) and yield ($t\ ha^{-1}$) for different wheat and barley screened for salinity during the season 2004

		Minerals (%)							
Yield ($t\ ha^{-1}$)	Growth stage	N	P	K	Na	K/Na	Ca	Mg	Cl
Biological	1	[A,B],-0.07	0.02	0.01	0.13	0.05	0.010	-0.003	0.09
	2	0.06	-0.05	-0.04	-0.16	0.08	-0.060	0.020	-0.02
Seed	1	-0.19[A]	0.14	0.21[A]	-0.07	0.22[A]	-0.060	-0.030	-0.07
	2	-0.08	0.05	0.09	-0.02	0.04	-0.010	-0.020	0.12
Straw	1	-0.001	-0.02	-0.10	0.19	-0.16	-0.080	0.010	0.12
	2	0.10	-0.08	-0.08	-0.18	0.08	-0.050	0.020	-0.07

[A]Significant at 5% probability level, [B]significant at 1% probability level, 1: 3-Leaf stages, 2: Elongation stage

Table 7: Correlation (r) between minerals content (N, P, K, Na, Ca, Mg, Cl and K/Na) and yield ($t\ ha^{-1}$) for different wheat screened for salinity during the season 2004

		Minerals (%)							
Yield ($t\ ha^{-1}$)	Growth stage	N	P	K	Na	K/Na	Ca	Mg	Cl
Biological	1	[A,B],-0.17	0.21	0.01	0.22	-0.06	-0.04	-0.06	0.07
	2	0.10	-0.11	-0.05	-0.06	-0.04	-0.04	-0.04	-0.16
Seed	1	-0.16	0.22	0.26[A]	-0.07	0.29[B]	-0.04	0.02	-0.26[A]
	2	-0.10	0.06	0.14	0.09	-0.04	-0.02	0.02	0.09
Straw	1	-0.13	0.16	-0.08	0.30[B]	-0.19	-0.03	-0.07	0.18
	2	0.16	-0.14	-0.10	-0.10	-0.03	-0.03	-0.07	-0.21

[A]Significant at 5% probability level, [B]significant at 1% probability level, 1: 3-Leaf stages, 2: Elongation stage

Table 8: Correlation (r) between minerals content (N, P, K, Na, Ca, Mg, Cl and K/Na) and yield ($t\ ha^{-1}$) for different barley screened for salinity during the season 2004

		Minerals(%)							
Yield ($t\ ha^{-1}$)	Growth stage	N	P	K	Na	K/Na	Ca	Mg	Cl
Biological	1	[A,B],0.14	-0.42[B]	-0.39[A]	-0.25	0.07	-0.26	0.15	-0.14
	2	-0.01	0.07	0.01	-0.37[A]	0.33[A]	-0.25	0.13	0.18
Seed	1	-0.22	-0.05	0.04	-0.09	0.18	-0.08	-0.09	0.17
	2	-0.10	0.03	0.05	-0.23	0.20	-0.09	-0.14	0.04
Straw	1	0.27	-0.47[A]	-0.49[B]	-0.26	0.005	-0.27	0.22	-0.01
	2	0.002	0.07	-0.02	-0.39[A]	0.34[A]	-0.27	0.22	0.19

[A]Significant at 5% probability level, [B]significant at 1% probability level, 1: 3-Leaf stages, 2: Elongation stage

Whereas, Na, Cl, Ca and Mg have a weak correlation with yield components in both wheat and barley genotypes at the tow growth stages.

In wheat genotypes Potassium (K) and K/Na ratio have a strong positive correlation with the seed yield at the three leaf stage (0.26 and 0.29), respectively (Table 7). This confirmed results of Salam *et al.* (1992), Li and Lui (1993), El-Hendawy *et al.* (2005), Salam *et al.* (1992), Chhipa and Lal (1995) and Munns *et al.* (1999). Sodium (Na) has a strong positive correlation (0.30) with the straw yield. However, N, P, Ca and Mg have weak correlations with yield components. Moreover, chloride element (Cl) showed a strong negative correlation (-0.26) with the seed yield. This confirmed the results obtained by Shaviv *et al.* (1990), Salam *et al.* (1992) and Zsoldos *et al.* (1990).

In barley genotypes (Table 8), P and K have a strong negative correlation with the biological yield (-0.42 and -0.39), respectively and with the straw yield (-0.47 and -0.49), respectively at the three leaf stage. Na has the same trend like P and K but at the elongation stage and it achieves (-0.37 and -0.39), respectively. K/Na ratio has a strong positive correlation with both biological yield and straw yield (0.33 and 0.34), respectively at the elongation stage of growth. However, N, Ca, Mg and Cl have weak correlations with the yield and yield components. In our results Ca has a weak correlation with the yield and yield components and this was in contrary to the results obtained by El-Hendawy *et al.* (2005).

CONCLUSIONS

From the results obtained in this study, it is clear that leaf samples at the three leaf stage are more indicative to reveal salinity resistance in both wheat and barley genotypes compared to the advanced growth stages. K and K/Na ratio have strongly correlated with the seed yield component in wheat genotypes, whereas in barley genotypes K/Na has similar trend with seed yield but was more strongly correlated to biological and straw yield. P and K have a strong correlation with the straw yield in barley genotypes. K/Na ratio could be used as selection criteria for biological, seed and straw yields in wheat and barley. Looking to yield and yield components the following genotypes: bread wheat (Jumaizah and Cham 6), durum wheat (Bin bashair, Cham3 and snap) and barley (Line5, Accsad176 and Rum) are selected as salinity resistant genotypes under Jordan conditions.

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