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El Sayed A.A., Khodier M.M.

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Field screening of some hull-less barley (*Hordeum vulgare* L.) against soil salinity in Egypt

A.A. El-Sayed* and M.M. Khodier**
*Hull-Less Barley Project, Field Crops Research Institute, ARC, 9 El Gamma Str., 12619 Giza, Egypt
**Soil Salinity Laboratory, Soil and Water Research Institute, ARC,
Bacos, 21616 Alexandria, Egypt

SUMMARY – Twenty nine hull-less and one hulled barley genotypes (*Hordeum vulgare* L.) were grown in the field at the Soil Salinity Lab., Alexandria, for one growth season (1998-99). These genotypes were tested for their performance under natural field salinity conditions. Soil salinity as electrical conductivity of saturated soil paste extract (EC_e) was determined and distinguished into two levels, 8.0 and 14.0 dS/m calculated as an average of the upper root zone of the whole season. Biological and grain yields as well as number of spikes were significantly affected ($P < 0.05$) by soil salinity levels and genotypes. Under EC_e 8.0 dS/m, genotypes numbers: 1, 9, 14, 17, 23 and 27 gave the highest biological and grain yields, while under EC_e 14.0 dS/m, these genotypes were shifted to four i.e. 1, 9, 17 and 23. Their relative yield decrease reached 0.248, 0.043, 0.30 and 0.129, respectively for biological yield, and 0.25, 0.103, 0.206 and 0.328, respectively for grain yield. Number of spikes was in line with biological and grain yields. Genotype 9 LHB93/4 (Rondo), seems to have good salt tolerance with regard to its absolute yield and also its minimum relative yield decrease on increasing soil salinity to the higher level. The check variety Giza 123 has higher salt tolerance than the hull-less genotypes. It produced 2.3-2.4 times that of the highest hull-less genotypes under both soil salinity levels. Future hull-less barley breeding programs for salt tolerance improvements might exploit genotype 9 LHB93/4 (Rondo) and Giza 123.

Key words: Hull-less barley, soil salinity, Egypt.

RÉSUMÉ – *"Criblage au champ de plusieurs génotypes d'orge (*Hordeum vulgare *L.) à grain sans enveloppe par rapport à la salinité du sol en Egypte". Vingt-neuf génotypes d'orge (*Hordeum vulgare *L.) à grain sans enveloppe et un génotype à grain avec enveloppe ont été cultivés au champ au Laboratoire de Salinité du Sol, Alexandrie, pendant une campagne (1998-99). Ces génotypes ont été testés pour leurs performances en conditions naturelles de salinité au champ. La salinité du sol en tant que conductivité électrique d'un extrait de pâte saturée du sol (EC_e) a été déterminée et différenciée en deux niveaux, 8,0 et 14,0 dS/m calculée comme moyenne de la zone racinaire supérieure pendant toute la campagne. Les rendements biologiques et en grain ainsi que le nombre d'épis ont été affectés de façon significative ($P < 0,05$) par les niveaux de salinité du sol et les génotypes. En EC_e 8.0 dS/m, les génotypes numéro: 1, 9, 14, 17, 23 et 27 ont donné les meilleurs rendements biologiques et en grain, tandis qu'en EC_e 14.0 dS/m, ces génotypes étaient au nombre de quatre à savoir 1, 9, 17 et 23. Leur diminution relative de rendement a atteint 0,248, 0,043, 0,30 et 0,129, respectivement pour le rendement biologique, et 0,25, 0,103, 0,206 et 0,328, respectivement pour le rendement en grain. Le nombre d'épis était en parallèle avec les rendements biologiques et en grain. Le génotype 9 LHB93/4 (Rondo) semble avoir une bonne tolérance à la salinité en ce qui concerne son rendement absolu et également sa diminution relative minimale de rendement avec une salinité croissante du sol jusqu'au niveau le plus élevé. La variété témoin Giza 123 a une meilleure tolérance à la salinité que les génotypes d'orge à grain sans enveloppe. Elle a produit 2,3-2,4 fois autant que les meilleurs génotypes à grain sans enveloppe aux deux niveaux de salinité du sol. De futurs programmes de sélection de l'orge à grain sans enveloppe pour améliorer la tolérance à la salinité pourraient exploiter les génotypes 9 LHB93/4 (Rondo) et Giza 123.*

Mots-clés : *Orge à grain sans enveloppe, salinité du sol, Egypte.*

Introduction

Soil salinity is a major factor influencing the growth and yield of crop plants in arid and semiarid regions. Salinity affects plant growth through water deficit, nutritional imbalance, and ion toxicity (Greenway and Munns, 1980). Salinity alters barley development where it delays germination, decreases germination percentage, decreases primary and secondary tillers and spikelets per spike (Ayers *et al.*, 1952; Francois *et al.*, 1986). Salt tolerance mechanisms in barley and wheat were reported to be osmotic adjustment, sodium-potassium discrimination and ion exclusion (Yeo, 1983;

Zhong and Dvorak, 1995; Volkmar *et al*., 1998). Evaluation of root and shoot tissue ion contents revealed that the wild barley *Hordeum jubatum* accumulated less sodium from the saline medium than the two row malting barley varieties Harrington and preferentially compartmentalize sodium in roots rather than shoot tissue, also the wild species maintained higher levels of calcium and had a more favorable Na/K ratio (Suhayda *et al.* 1992). The wild species was reported as habitat to soils with pH values >8.0, electrolyte conductivities of 16 dS/m and Na, Mg and SO_4 concentrations of 100 to 200 mol/m^3 in saturated soil extracts (Best *et al*., 1978). The observable differences in salt tolerance refer to physiological mechanisms concerning ion accumulation, selectivity and compartmentation. These differences are mainly due to the variation in genetic background. Screening and selection for salt tolerance is important to help identify parental breeding stocks.

Generally, barley is considered a salinity tolerant crop (Ayers and Westcot, 1985). It has been particularly satisfactory as one of the early crops planted in the process of reclamation of saline lands. The threshold salinity tolerance of barley was listed as 8.0 dS/m (Ayers and Westcot, 1985), but Hassan *et al.* (1970) found no decrease in the production of dry matter by vegetative parts up to an EC of the soil solution at 12 dS/m. The indication of good salinity tolerance at one growth stage such as germination and seedling does not necessarily mean that other stages will also have good salt tolerance, so screening throughout the entire life cycle is very important. Since there is no information available on the salt tolerance of hull-less barley, it seemed desirable to investigate the differences among some introduced hull-less barley genotypes in order to make a better recommendation for planting on saline soils spread through the Egyptian cultivated area and for the future exploitation in breeding programs.

Materials and methods

Commercial control variety Giza 123 together with 29 hull-less barley introduction genotypes were supplied by the Egyptian/French Hull-Less Barley Project, Field Crops Research Institute, ARC, Egypt (Table 1). They were planted in the Research Farm at Soil Salinity Lab., Alexandria in the growing season 1998-99.

Part of the new reclaimed area of Maryout is characterized by a highly saline shallow water table (80 cm) that causes resalinization especially in the fallow time through capillary rise. The upper layer is sandy clay to clay loam texture underlined by clay intermediate with shells, permits good water permeability to the live drain. Contents of calcium carbonate and organic matter are 7% and 0.8%, respectively. Soil salinity as electrical conductivity of saturated paste extract (EC_e) was determined with the methods of U.S. Salinity Laboratory Staff (1954), and ranged 7.0-25.0 dS/m. The field was divided into plots 4 m x 5 m isolated with brick walls from three sides to a depth of 70 cm. The plots were sown with the barley genotypes, each genotype represented by a row 1.8 m long and 0.3 m apart. Soil salinity measurements of plots were continued throughout the growth season and averaged for the upper 30 cm root-zone. Two levels of soil salinity 7.0 and 14.0 dS/m with three replications were chosen to evaluate the performance of barley genotypes under salinity stress. The plots were irrigated with Nile water after sowing twice and the rest of plant life adapted to rainfall. The plants were fertilized with 15.3 kg P/ha as super phosphate prior to sowing and 175 kg N/ha as ammonium nitrate on two doses. Data on biological yield, grain yield and number of spikes per plot for the tested genotypes were subjected to statistical analysis as RCBD according to Steel and Torrie (1980).

Results and discussion

The performance of tested barley genotypes under two levels of soil salinity EC_e 8.0 and 14 dS/m is shown in Table 2. Biological yield, grain yield and number of spikes per plot were significantly affected by soil salinity and genotype. Biological yield of the hull-less barley genotypes under EC_e 8.0 dS/m ranged 61.7-289.3 g/plot. Genotypes # 1, 9, 12, 14, 17, 23 and 27 were the highest. At the higher soil salinity level of EC_e 14.0 dS/m, the range was 55.2-228.1 g/plot, the highest genotypes were # 9, 14, 17 and 24 with relative yield decrease of the first level reaching 0.043, 0.0300, 0.129 and 0.500. The genotype # 9 seemed to be tolerant, based on its absolute yield at the higher soil salinity level and its sensitivity to increasing salt concentration. The check variety Giza 123, a salinity-tolerant hulled type, yielded 2.3 times the highest hull-less type.

Table 1. Names and pedigree of 30 barley genotypes tested for salt tolerance in the study

Ent. No.	Name/Pedigree
1	ALISO'S'/CI 03909-2 CMB88A-0529-2M-2Y-3B-11B-0Y
2	CI 9984
3	ALISO/CI 3909.2//FALCON-BAR/3/HIGO CMB93. 993-C-9Y-3M-0Y
4	Giza 129
5	BOLDO/POLEO/4/RHODES//TB-B/CH/3/GLORIA-BAR/COPAL/5/BERMEJO/6/HIGO CMB 91 A. 935-N-3B-1Y-0B
6	891M-616 SEL, 1AP BF
7	ALISO/CI 3909 .2//MOLA/SHYRI/3/MOLA/ALELI … CMB 93. 596-D-6Y-2M-0Y
8	Giza 131
9	LHB 93/4 (RONDO, ITALIAN VARIETY)
10	CM67-B/CENTENO//CAM-B/3/ROW 906.73/4/GLORIA-BAR/COME-B/5/FALCON-BAR/6/LINO CMB 93. 747-I-5Y-1M-0Y
11	ATACO/ACHIRA//HIGO CMB 91 A. 1192-0A-1B-1Y-0B
12	ATACO/BERMEJO//HIGO CMB 91 A. 937-C-9B-1Y-0B
13	ICNBF8-617 SEL , 3AP
14	BOLDER/POLEO/4/RHODES//TS-B/CHZO/3/GLORIA-BAR/COPAL/5/VIRINGA/6/ ATACO CMB 941 A. 559-A-7B-1Y-0B
15	ATACO/BERMEJO//HIGO CMB 91 A. 1143-C-23-1Y-0B
16	ATACO/ACHIRA//HIGO CMB 91 A. 1192-1-3B-1Y-0B
17	GLORIA-BAR/IAR-H-485//ACHIRA/3/LINO CMB 91 A. 542-A-1B-1Y-0B
18	CARDO'S'/BERMEJO'S' CMB 90-0131-2Y-1B-0Y
19	ICNBF8-653 SEL , 5AP
20	ICNBF8-852 SEL , 6AP
21	ATACO//ACHIRA//HIGO CMB 91 A. 1192-AG-5B-1Y-0B
22	GLORIA-BAR/IAR-H-485//ACHIRA/3/LINO CMB 91 A. 542-C-4B-1Y-0B
23	ICNBF8-611 SEL , 3AP
24	ATACO/BERMEJO//HIGO CMB 91 A. 937-M-4B-1Y-0B
25	GLORIA-BAR/IAR-H-485//ACHIRA/3/LINO CMB 91 A. 542-D-2B-IY-0B
26	BF891M-654 SEL , 1AP
27	BF891M-583 SEL , 5AP
28	LHB 93/1 (PLAISANT, FRENCH VARIETY)
29	LHB 93/2 (CI 13346 – HANNA)
30	Giza 123

Grain yield of the hull-less barley genotypes ranged 31.5-153.7 g/plot and 20.1-116.7 g/plot, respectively under soil salinity EC_e 8.0 and 14.0 dS/m. The highest grain yield genotypes at EC_e 8.0 were the same as biological yield, but at EC_e 14.0 the highest were # 1, 9, 17, 23. Their relative yield decreases due to soil salinity rising from 8.0 to 14.0 dS/m were 0.250, 0.103, 0.206 and 0.328, respectively. The genotypes seemed to be salinity tolerant scaled by its absolute and relative grain yield. The check variety also had grain yield 2.41 times the highest hull-less type at the higher soil salinity level. Number of spikes per plot was in line with grain yield where genotypes # 9, 14, 17 and 23 were the highest hull-less genotypes. Their relative decreases on rising soil salinity from 8.0 to 14.0 dS/m were 0.086, 0.354, 0.053 and 0.034, respectively. The genotype # 9 showed good salinity tolerance that permitted good germination or tillering and also was able to produce higher biological and grain yields. This genotype is less salinity tolerant than the hulled Giza 123, but it has a greater chance to improve its salt tolerance through plant breeding.

Table 2. Biological yield, grain yield and number of spikes (per plot 1.8 m x 0.3 m) of barley genotypes as affected by soil salinity expressed as electrical conductivity of saturated paste extract

Genotype	Soil salinity ECe (dS/m)								
	Biological yield (g/plot)			Grain yield (g/plot)			Spikes per plot		
	8	14	Mean	8	14	Mean	8	14	Mean
1	248.3	186.7	217.5	121.5	91.1	106.3	85.3	64.7	75.0
2	165.0	126.7	145.9	52.8	40.6	46.8	53.7	46.0	49.9
3	145.0	126.7	135.9	46.7	53.7	50.2	47.0	39.7	43.4
4	136.7	66.7	101.7	68.9	34.8	51.9	54.3	35.3	44.8
5	161.7	121.7	141.7	73.8	45.7	59.8	55.3	37.0	46.2
6	175.6	137.3	156.5	85.6	69.9	77.8	61.2	51.9	56.6
7	137.1	73.3	105.2	64.7	32.7	48.7	36.3	22.3	29.3
8	136.7	93.5	115.1	73.3	41.9	57.6	48.7	32.5	40.6
9	238.3	228.1	233.2	130.2	116.7	123.5	90.7	83.0	86.9
10	196.7	102.1	149.4	93.0	43.3	68.2	55.0	30.3	42.7
11	134.1	70.0	102.1	61.5	30.8	46.2	49.4	42.0	45.7
12	207.0	123.3	165.2	125.3	54.5	89.9	77.3	46.0	61.7
13	180.0	80.0	130.0	93.0	36.5	64.8	61.9	41.3	51.6
14	289.3	202.4	245.9	143.5	73.6	108.6	144.0	93.0	118.5
15	170.0	100.0	135.0	78.5	39.6	59.1	91.0	50.0	70.5
16	151.7	130.0	140.0	70.9	54.3	62.6	59.7	45.7	52.7
17	258.3	225.0	241.7	126.4	100.4	113.4	107.7	102.0	104.9
18	125.0	48.3	86.7	57.9	20.1	39.0	43.3	21.0	32.2
19	153.3	63.3	108.3	69.9	24.4	47.2	52.7	22.0	37.4
20	185.0	93.3	139.2	95.8	46.4	71.1	65.7	37.0	51.4
21	126.7	108.3	117.5	54.2	45.2	49.7	43.7	38.0	40.9
22	120.0	95.0	107.5	54.3	43.6	49.0	38.3	34.3	36.3
23	240.0	218.3	229.2	153.7	103.3	128.5	97.0	93.7	95.4
24	166.7	105.0	135.9	81.2	47.3	64.3	63.3	47.3	55.3
25	61.7	55.2	116.9	31.5	37.1	34.3	24.3	36.5	30.4
26	121.7	120.0	120.9	57.5	63.1	60.3	43.3	46.7	45.0
27	271.7	151.7	211.7	125.8	72.6	99.2	88.3	68.3	78.3
28	141.4	105.7	123.6	79.6	56.8	68.2	50.7	34.7	42.7
29	106.7	95.4	101.1	60.2	39.0	49.6	66.0	50.6	58.3
30	686.7	526.7	606.7	357.0	281.4	319.2	189.3	150.7	170.0
LSD (0.05)	70.22			34.43			22.37		
CV%	38.1			38.8			32.7		

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