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Differential Response of Barley (*Hordeum vulgare L.)* to Salinity

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استجابة محصول الشعير لإجهاد الملوحة

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الخلاصة: تمت دراسة (4) أصناف مختارة من الشعير (جماح 51 ، وجماح 54 ، وجماح 98، وجماح 136) مع صنفين من أصناف الشعير المحلية هما بيشر (متأخر النضج) ودوراقي (مبكر النضج) وذلك للتعرف على مدى استجابتها لخمس مستويات من ملوحة ماء الري (1 (الشاهد) ، 3 ، 9 ، 12 و15 ديسيسمن/م) خلال المواسم الشتوية في الأعوام 2002-2003م و 2003-2004م وذلك في أصص تحتوي على تربة رملية طميية. أشارت النتائج إلى أن تأثير السنوات والملوحة والأصناف كان عال المعنوية لجميع الصفات تحت الدراسة ، أما بالنسبة للتداخلات فقد كان تأثير تداخل السنوات والملوحة والسنوات مع الأصناف عال-المعنوية لجميع الصفات تحت الدراسة ، بينما كان تداخل الأصناف مع الملوحة عال المعنوية بالنسبة لارتفاع النبات (سم) والوزن الجاف (طن/ هكتار) . بينما لم يكن هناك تأثير معنوي للتداخل بين العوامل الثلاثة (الملوحة ، الأصناف والسنوات) . كان تأثير الملوحة السلبي ظاهراً على كل صنف في جميع الصفات تم تقييم تحمل الملوحة على أساس معامل مقاومة الإجهاد لكل مستوى من الملوحة وعلاقته بالشاهد، وكذلك على متوسط قيم النمو والإنتاج لمعاملات الملوحة بالنسبة لكل صفة. ظهر بان الصنف جماح 136 كان الأعلى والأكثر استقرارا في تحمله للملوحة بينما تفاوتت الأصناف الأخرى في درجة تحملها لمستويات الملوحة المختلفة.

ABSTRACT: Four elite barley cultivars (Jimah 51, Jimah 54, Jimah 98 and Jimah 136) along with two local cultivars, Beecher (late maturity) and Duraqi (early maturity), were investigated for their response to five levels of irrigation water salinity viz. control (1 dS m^{-1}), 3, 9, 12 and 15 dS m^{-1} during the winter seasons of 2002-03 and 2003-04 in pots containing sandy loam soil. The results indicated that the main effects of years, salinity and cultivars were highly significant ($p<0.01$) with respect to all the characters studied. Among the interactions, the effects of year x salinity and year x cultivar were highly significant ($p<0.01$) for all the characters, whereas that of salinity x cultivar was highly significant ($p<0.01$) for only two characters viz. plant height and dry matter yield. However, 3-factor interaction was not significant ($p>0.05$) for any character. Adverse effects of salinity were evident in the cultivars for all characters. Salinity tolerance of cultivars was assessed using the concepts of both stress susceptibility index at each higher salinity level in relation to control (lowest salinity level) and mean value over the salinity treatments with respect to each character. Among all the cultivars tested, Jimah 136 was found to have a consistently high degree of salinity tolerance. All other cultivars, however, responded differentially to different levels of salinity for different characters.

Keywords: Barley, *Hordeum vulgare*, salinity, growth attributes, forage yield.

Introduction

Irrigation is the key to agricultural productivity in arid and semi-arid regions. Of late, these regions have been affected either by soil salinity due to poor irrigation practices or by water salinity due to sea water intrusion near the coast. Under such conditions, researchers have to seek saline tolerant cultivars of crops grown in the region, which can then be subjected to crop improvement for high yield and quality. Plant breeders, along with physiologists, are now modifying

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crops to suit adverse saline soil or irrigation water conditions while maintaining reasonable and reliable grain or forage yields (Shannon, 1985; Wyn Jones and Gorham, 1986; Gorham, 1991; Qualset and Corke, 1991; Nadaf *et al.,* 2001). Forage yields of barley (*Hordeum vulgare* L.) are directly dependent upon agronomic growth attributes like plant height, number of tillers, leaf length and leaf number per plant (Jaradat *et al*,, 2004), which have been proved stable and consistent indicators of forage yield. Salinity (McLeod, 1982), drought (Fukai *et al.,* 1990) and other environmental stresses like temperature (Hockett, 1990) can greatly affect development of these stable characters. Several workers described the effect of salinity on different growth and yield related characters right from seedling (Salim, 1991) to adult ((Rawson *et al,,* 1988; McLeod, 1982; Hocket and Nilan, 1985) stages of barley. In Oman barley is grown for forage during winter. Several exotic cultivars have been selected, based on their high forage productivity in comparison with local barley cultivars.

In light of the above information, the present investigation was conducted consecutively in 2002-03 and 2003-04 utilizing promising barley cultivars at the Agriculture Research Center, Rumais, Oman. This investigation was undertaken to determine the effect of different salinity levels of irrigation water on four agronomic traits associated with forage barley in order to enable selection of the cultivars highly tolerant to salinity for general cultivation at saline sites or use in barley breeding.

Materials and Methods

Four cultivars of barley (Jimah 51, Jimah 54, Jimah 98 and Jimah 136) recommended by the Ministry of Agriculture and Fisheries, Oman, for cultivation in Oman, along with two local checks viz. Duraqui (early cultivar, flowers within two months) and Beecher (late cultivar, flowers within three months) were used in the study. The physical and chemical characteristics of the experimental soil are presented in Table 1.

The trial was conducted consecutively for two years, during the winter seasons of 2002-03 and 2003-04 in two-factor completely randomized design with three replications using six cultivars under six levels of irrigation water salinity, viz. Control (1 dS m^{-1}), 3, 6, 9, 12 and 15 dS m^{-1} in pots of 20-cm diameter. In both years, the crop was planted in mid-November and harvested for forage as and when the cultivars attained 50 % flowering stage. Except for Duraqui, which attained 50 % flowering between 56 and 60 days, other cultivars took about 80-87 days after planting. In both years, fresh soil initially collected from the same land was used. Four plants grown in each pot were fertilized with the recommended dose of 100 kg N, 90 kg P_2O_5 and 60 kg K_2O/ha in the form of urea, triple superphosphate and potassium sulphate, respectively. The entire quantities of potassium and phosphate fertilizers along with ¼ nitrogen fertilizer were applied before planting, whereas the remaining nitrogen was applied in three splits of ¼ N each, one week after planting, at heading and milky grain stages, respectively.

Table 1. Values of some chemical and physical characteristics of the experimental soil.

	Characteristic	Value
Chemical:		
	EC (1:5) dS/m	2.58-2.16
	pH (1.5)	7.40-7.50
	$CaCO_3$ (%)	27.80
	N (%)	0.076
	Av.P (ppm)	833.90
Physical:		
	Gravel (%)	0.0
	Coarse sand (%)	0.60
	Fine sand (%)	63.30
	Silt (%)	27.60
	Clay (%)	8.50
	Texture	Sandy loam

The pots of each cultivar were frequently irrigated with water corresponding to the described levels of salinity till their germination and later thrice a week till a week prior to harvest. Sea water of electrical conductivity 48.5 $\pm$ 2 dS m^{-1} was used as a source of salinity as it incorporates several salts commonly encountered in saline soils, namely high concentrations of sodium, chloride, sulphate and boron and a low calcium to magnesium ratio. The salinity treatments were prepared in 100-liter plastic drums by diluting the seawater by control water. Protective measures against pests and diseases were taken whenever necessary.

The observations on plant height (cm), number of tillers/ plant and green matter weight (g)/ plant were recorded at 50 % flowering and dry matter weight (g) was recorded in the laboratory after drying green matter in the oven at 70°C for 18-24 hrs (AOAC, 1984). The

Table 2. Statistical parameters in respect of plant height, number of tillers, green matter weight/plant and dry matter weight/plant, both in g. *Significant at 0.05 level of probability; ** Significant at 0.01 level of probability; NS - Not significant.

Characters Statistical Parameters	Plant Height (cm)		Number of Tillers		Green Matter		Dry Matter	
	LSD		LSD		LSD		LSD	
	F-Test	(5%)	F-Test	(5%)	F-Test	(5%)	F-Test	(5%)
Year	**	1.53	**	0.91	**	7.65	**	1.69
Salinity	**	2.65	**	1.57	**	13.26	**	2.93
Year x Salinity	**	3.74	**	2.22	**	18.75	**	4.15
Varieties	**	2.65	**	1.57	**	13.26	**	2.93
Year x Varieties	**	3.74	**	2.22	**	18.75	**	4.15
Salinity x Varieties	**	6.48	NS	-	NS	-	**	7.19
Year x Salinity x Varieties	NS	-	NS	-	NS	-	NS	0
CV (%)	11.61		26.0		20.05		11.61	

data on the above characters were subjected to statistical analysis according to the methods of Gomez and Gomez (1984) using the MSTATC computer program (MSTAT, 1989). A stress susceptibility index (S) for the cultivars was determined on the basis of each character in the high salinity irrigation treatment relative to the control (Fischer and Maurer, 1978; Kelmen and Qualset, 1991). The S is defined as:

$$S = [1- (Y_{ij} / Y_{ic})] / [1- (Y_{.j} / Y_{.c})],$$

where Y_{ij} = character expression of ith genotypes in the jth saline treatment, Y_{ic} = character expression of the same cultivar in the control treatment, $Y_{.j}$ = mean character expression of all cultivars in the jth saline treatment, and $Y_{.c}$ = mean character expression of all the cultivars in the control treatment. Low S values indicate low susceptibility or high tolerance to environmentally induced stress.

Results and Discussion

Table 2 shows the ANOVA with respect to plant height, number of tillers, green matter weight / plant and dry matter weight/plant. The results indicate that the main effects of years, salinity and cultivars were highly significant ($p<0.01$) with respect to all the characters studied. Among the interactions, the effects of year x salinity and year x cultivar were highly significant ($p<0.01$) for all the characters, whereas effects of salinity x cultivar were highly significant ($p<0.01$) for only two characters, viz. plant height and dry matter yield. However, 3-factor interaction was not significant ($p>0.05$) for any character. Adverse effects of salinity were evident in the cultivars for all characters. Salinity tolerance of cultivars was assessed using the concepts of both stress susceptibility index at each higher salinity level in relation to control (lowest salinity level) and mean value over the salinity treatments with respect to each character. However, stress susceptibility index values were found to vary for each character among the cultivars with different levels of salinity.

Plant height

In both years, in general there was significant reduction in mean plant height with increased level of salinity ($p<0.05$) from the controls to higher levels of salinity (Table 3). However, means of plant height at 3 dS m^{-1} and 6 dS m^{-1} were not significantly ($p>0.05$) different during 2002-03. Decrease in plant height from control to 3 dS m^{-1} was significant in both the years (Table 3): 7.1 % in 2002-03 and 5.7 % in 2003-04. The decrease from control to 6 dS m^{-1} was 6.9 % in 2002-03 and 16.2 % in 2003-04, whereas the reduction in plant height was 35.0 % in 2002-03 and 29.8 % in 2003-04 at 15 dS m^{-1} as compared to control. With respect to mean plant height across salinity levels, in 2002-03, J-136 (67. 8 cm) recorded the significantly ($p<0.05$) highest mean plant height, followed by early local check, Duraqui (63.0 cm) and J-54 (56.3 cm), while in 2003-04, Duraqui (48.6 cm) and J-54 (42.8 cm) cm) were significantly taller than other cultivars. Stress

Table 3. Mean plant height (cm) of barley cultivars during the winters 2002-03 and 2003-04 along with their stress susceptibility indexes (Scj) based on plant height. The means with different letters are signficantly different at P≤0.05 according to LSD and stress susceptibility index of 'j' (dS), high salinity treatment relative to 'c' (dS), low salinity treatment.

Cultivar	2002-2003												2003-3004											
	Salinity Level (dS/m)							Stress Susceptibility Indices					Salinity Level (dS/m)							Stress Susceptibility Indices				
	Control	3	6	9	12	15	Mean	S_{c3}	S_{c6}	S_{c9}	S_{c12}	S_{c15}	Control	3	6	9	12	15	Mean	S_{c3}	S_{c6}	S_{c9}	S_{c12}	S_{c15}
J 51	60.0	60.7	54.3	53.0	47.7	38.7	52.4 ^{d}	-0.16	1.37	0.72	0.73	1.01	59.2	45.3	42.7	36.6	33.3	25.1	40.4 ^{b}	4.12	1.72	1.33	1.82	1.93
J 54	71.7	62.3	64.7	56.3	43.7	39.3	56.3 ^{c}	1.83	1.41	1.32	1.38	1.29	50.7	50.4	41.7	38.1	41.2	34.5	42.8 ^{b}	0.11	1.09	0.87	0.78	1.07
J 98	68.7	57.5	60.3	54.0	48.0	37.3	54.3 ^{cd}	2.28	1.76	1.32	1.06	1.30	42.2	40.5	38.6	30.1	30.6	29.2	35.2 ^{c}	0.72	0.53	1.00	1.15	1.04
J 136	72.3	73.3	71.7	65.0	65.3	59.0	67.8 ^{a}	-0.19	0.13	0.63	0.34	0.53	39.6	41.5	35.3	32.4	34.0	33.3	36.0 ^{c}	-0.85	0.66	0.63	0.59	0.53
Beecher	61.7	60.5	59.3	52.0	45.7	47.0	54.4 ^{cd}	0.27	0.55	0.97	0.92	0.68	48.7	42.5	36.7	35.6	40.7	41.2	40.9 ^{b}	2.24	1.52	0.94	0.68	0.52
Duraqi	78.2	68.7	73.7	65.3	45.3	46.7	63.0 ^{b}	1.69	0.83	1.01	1.48	1.15	54.8	58.2	52.3	37.7	44.6	43.9	48.6 ^{a}	-1.10	0.28	1.09	0.78	0.66
Mean	68.8 ^{a}	63.8 ^{b}	64.0 ^{b}	57.6 ^{c}	49.3 ^{d}	44.7 ^{e}							49.2 ^{a}	46.4 ^{a}	41.2 ^{b}	35.1 ^{c}	37.4 ^{c}	34.5 ^{c}						

Table 4. Mean number of tillers/plant of barley cultivars during the winters 2002-03 and 2003-04 along with their stress susceptibility indexes (Scj) based on number of tillers/plant. The means with different letters are significantly different at P≤0.05 according to LSD and stress susceptibility index of 'j' (dS), high salinity treatment relative to 'c' (dS), low salinity treatment.

Cultivar	2002-2003												2003-3004											
	Salinity Level (dS/m)							Stress Susceptibility Indices					Salinity Level (dS/m)							Stress Susceptibility Indices				
	Control	3	6	9	12	15	Mean	S_{c3}	S_{c6}	S_{c9}	S_{c12}	S_{c15}	Control	3	6	9	12	15	Mean	S_{c3}	S_{c6}	S_{c9}	S_{c12}	S_{c15}
J 51	14	9	10	15	15	8	12 ^{b}	2.37	0.97	-0.28	-0.34	1.16	24	21	19	20	16	11	19 ^{a}	1.05	0.89	0.48	0.72	0.97
J 54	15	14	16	16	16	11	15 ^{a}	0.46	-0.22	-0.13	-0.23	0.67	24	25	21	19	18	18	21 ^{a}	-0.23	0.59	0.68	0.58	0.47
J 98	13	8	7	5	5	5	7 ^{c}	3.02	1.61	3.57	2.31	1.60	27	23	21	17	12	13	19 ^{a}	1.06	0.98	1.10	1.18	0.96
J 136	8	11	8	8	6	7	8 ^{c}	-2.96	0.14	0.25	0.74	0.21	27	25	20	18	15	11	19 ^{a}	0.64	1.03	0.99	0.95	1.05
Beecher	13	9	5	8	5	7	8 ^{c}	2.37	2.00	2.13	2.09	1.12	23	22	19	13	9	6	15 ^{b}	0.13	0.64	1.25	1.24	1.31
Duraqi	10	12	5	9	5	6	8 ^{c}	-1.47	1.52	0.21	1.84	0.97	14	6	6	5	4	3	6 ^{c}	4.95	2.42	1.84	1.57	1.44
Mean	12 ^{a}	11 ^{ab}	9 ^{b}	10 ^{b}	9 ^{bc}	7 ^{c}							23 ^{a}	20 ^{b}	18 ^{b}	15 ^{c}	12 ^{d}	10 ^{d}						

susceptibility index values of J-136 were low and consistent in both years at all higher levels of salinity, indicating their superiority in tolerance to salinity.

Number of tillers/plant

The numbers of tillers per plant were significantly ($p<0.05$) higher during 2003-04 than during 2002-03. There was a significant reduction in mean number of tillers with increased level of salinity ($p<0.05$) from the control to higher level of salinity up to 12 dS m^{-1} in both years. However, means of number of tillers in the control and 3 dS m^{-1} were not significantly ($p>0.05$) different in 2002-03, whereas those at 12 dS m^{-1} and 15 dS m^{-1} were not significantly ($p>0.05$) different in any of the years (Table 4). The decrease in the number of tillers from the control to 3 dS m^{-1} was 11. 8 % in 2003-04. The decrease from the control to 6 dS m^{-1} was 29.5 % in 2002-03 and 23.0 % in 2003-04, whereas the reduction in the number of tillers was 39.1 % in 2002-03 and 54.9 % in 2003-04 at 15 dS m^{-1} as compared to the control. With respect to mean number of tillers/plant over salinity levels, in 2002-03, J-54 (14.9) recorded the significantly ($p<0.05$) highest mean number of tillers, followed by J-51 (11.8) and J-136 (8.1), whereas in 2003-04, J-54 (20.8) recorded the significantly ($p<0.05$) highest mean number of tillers, followed by J-136 (19.2) and J-51 (18.8). Stress susceptibility index values of J-54 and J-136 were low and consistent in both years at all higher levels of salinity, indicating their superiority in tolerance to salinity.

Green matter yield (g/plant)

Green matter yield showed a progressive and significant ($p<0.05$) decreasing trend from the control to higher salinity levels in both years (Table 5). Green matter yield was significantly reduced ($p<0.05$); from the control by 13.4 % in 2002-03 and by 31.7 % in 2003-04 at 3 dS m^{-1}. It was further significantly reduced ($p<0.05$) by 38.4 % in 2002-03 and 48.2 % in 2003-04 at 6 dS m^{-1} from the control. Further decrease was to the extent of 55 % or more from the control. With respect to mean green matter yield over salinity levels, in 2002-03, J-136 (199.2 g/plant) recorded the significantly ($p<0.05$) highest mean green matter yield, followed by Beecher (194.45 g/plant) and J-98 (191.3 g/plant), whereas in 2003-04, J-136 (124.7 g/plant) recorded the significantly ($p<0.05$) highest mean green matter yield, followed by J-98 (118.9 g/plant) and J-54 (111.1 g/plant). Stress susceptibility index values of J-136 were low in relation to the control and consistent in both years at all higher levels of salinity, indicating its superiority in tolerance to salinity.

Dry matter yield (g/plant)

Dry matter yield also showed progressive and significant ($p<0.05$) decreases from the control to higher salinity levels in both years (Table 6). Dry matter yield was significantly reduced ($p<0.05$) by 16.22 % in 2002-03 and by 19.87 % in 2003-04 from the control at 3 dS m^{-1}. It was further reduced significantly ($p<0.05$) by 41.8 % in 2002-03 and 35.0 % in 2003-04 from the control at 6 dS m^{-1}. Further decrease was to the extent of 54 % or more in 2002-03 and 46.89 % in 2003-04 or more from control. With respect to dry matter yield over salinity levels, in 2002-03, J-51 (47.1 g/plant) recorded the significantly ($p<0.05$) highest mean dry matter yield followed by J-54 (40.6 g/plant) and Beecher (40.2 g/plant), while in 2003-04, J-54 (28.5 g/plant) recorded the significantly ($p<0.05$) highest mean green matter yield, followed by J-136 (27.7 g/plant) and J-51 (27.4 g/plant). Stress susceptibility index values of J-136 were low and consistent in both years at all higher levels of salinity in relation to the control, indicating their superiority in tolerance to salinity.

Other workers have also observed adverse effect of salinity on growth of barley as reductions in plant height, number of tillers, green matter and dry matter yields (Demiral *et al.,* 2005). Many authors have reported variability in salt tolerance within species (Shannon, 1985; Kelmen and Qualset, 1991; Gonzales, 1996) but the criteria of selection for salt tolerance have not been consistent among investigators. Salinity tolerance of a crop can be assessed either in terms of its physiology as a small relative growth reduction due to salinity or on an absolute plant basis as revealed by high growth rate in the presence or absence of salinity (Rawson *et al.,* 1988). On the other hand, Shannon (1985) discussed salinity tolerance in terms of either relative tolerance, or by mean productivity differences between saline and non-saline environments, or across a range of saline environments with their merits and demerits in respect of both low yielding and high yielding lines. Later, Kelmen and Qualset (1991) applied the concept of relative tolerance for selection of a cultivar using its stress susceptibility index with reference to particular

Table 5. Mean green matter weight/plant (g) of barley cultivars during the winters 2002-03 and 2003-04, along with their stress susceptibility indexes (Scj) based on green matter weight/plant. The means with different letters are significantly different at P≤0.05 according to LSD and stress susceptibility index of 'j' (dS), high salinity treatment relative to 'c' (dS), low salinity treatment.

Cultivar	2002-2003											
	Salinity Level (dS/m)							Stress Susceptibility Indices				
	Control	3	6	9	12	15	Mean	S_{c3}	S_{c6}	S_{c9}	S_{c12}	S_{c15}
J 51	286.58	282.20	168.67	149.60	122.67	82.93	182.11^{a}	0.11	1.07	0.87	0.90	0.92
J 54	308.13	244.20	187.47	135.17	112.43	66.63	175.67^{a}	1.55	1.02	1.02	1.00	1.02
J 98	311.43	286.87	213.30	154.43	109.40	72.50	191.32^{a}	0.59	0.82	0.92	1.02	1.00
J 136	343.50	284.67	195.20	158.80	133.13	79.67	199.16^{a}	1.28	1.12	0.98	0.96	1.00
Beecher	342.67	295.67	200.07	138.40	115.60	74.50	194.48^{a}	1.02	1.08	1.08	1.04	1.02
Duraqi	231.40	185.57	158.47	83.27	67.40	42.33	128.07^{a}	1.48	0.82	1.16	1.11	1.06
Mean	303.95^{a}	263.19^{b}	187.19^{c}	136.61^{d}	110.11^{e}	69.76^{f}						

Cultivar	2003-3004											
	Salinity Level (dS/m)							Stress Susceptibility Indices				
	Control	3	6	9	12	15	Mean	S_{c3}	S_{c6}	S_{c9}	S_{c12}	S_{c15}
J 51	273.33	110.00	83.33	76.67	56.67	30.00	105.00^{b}	1.88	1.44	1.25	1.13	1.11
J 54	208.87	150.00	123.33	84.43	60.00	40.00	111.11^{ab}	0.89	0.85	1.03	1.02	1.01
J 98	225.38	163.51	115.63	98.93	59.32	51.10	118.98^{ab}	0.87	1.01	0.97	1.05	0.97
J 136	215.47	167.13	113.30	118.10	83.13	50.97	124.68^{a}	0.71	0.98	0.78	0.88	0.95
Beecher	182.23	144.44	106.67	85.57	53.33	40.00	102.04^{b}	0.65	0.86	0.92	1.01	0.97
Duraqi	139.03	114.40	102.70	63.70	59.13	35.79	85.79^{c}	0.56	0.54	0.94	0.82	0.93
Mean	207.39^{a}	141.58^{b}	107.49^{c}	87.90^{d}	61.93^{e}	41.31^{f}						

Table 6. Mean dry matter weight/plant (g) of barley cultivars during the winters 2002-03 and 2003-04 along with their stress susceptibility indices (Sc.j) based on dry matter weight/plant. The means with different letters are significantly different at P≤0.05 according to LSD and stress susceptibility index of 'j' (dS), high salinity treatment relative to 'c' (dS), low salinity treatment.

Cultiovar	2002-2003											
	Salinity Level (dS/m)							Stress Susceptibility Indices				
	Control	3	6	9	12	15	Mean	S_{c3}	S_{c6}	S_{c9}	S_{c12}	S_{c15}
J 51	78.40	71.73	43.77	36.93	30.37	21.40	47.10^{a}	0.52	1.06	0.98	1.01	1.00
J 54	75.27	55.27	40.70	28.93	26.50	16.80	40.58^{b}	1.64	1.10	1.14	1.06	1.06
J 98	38.97	41.03	29.40	23.27	18.53	12.33	27.26^{d}	-0.33	0.59	0.75	0.86	0.94
J 136	51.97	41.07	26.13	30.13	24.70	20.27	32.38^{c}	1.29	1.19	0.78	0.86	0.84
Beecher	72.30	57.57	38.80	29.53	26.07	16.63	40.15^{b}	1.26	1.11	1.10	1.05	1.05
Duraqi	34.43	27.68	25.67	12.83	11.00	7.40	19.84^{e}	1.21	0.61	1.16	1.12	1.08
Mean	58.56^{a}	49.06^{b}	34.08^{c}	26.94^{d}	22.86^{d}	15.81^{e}						

Cultiovar	2003-3004											
	Salinity Level (dS/m)							Stress Susceptibility Indices				
	Control	3	6	9	12	15	Mean	S_{c3}	S_{c6}	S_{c9}	S_{c12}	S_{c15}
J 51	63.62	30.70	23.97	21.17	15.80	9.13	27.40^{bc}	2.60	1.78	1.42	1.22	1.18
J 54	45.42	37.17	35.99	23.82	16.47	11.74	28.44^{ab}	0.91	0.59	1.02	1.03	1.02
J 98	37.66	36.54	27.50	26.10	15.03	13.90	26.12^{a}	0.15	0.77	0.66	0.97	0.87
J 136	40.49	35.63	26.00	28.66	21.29	14.00	27.68^{a}	0.60	1.02	0.62	0.77	0.90
Beecher	39.45	37.04	27.50	22.00	13.97	11.28	25.21^{ab}	0.31	0.87	0.94	1.05	0.98
Duraqi	21.83	22.00	20.57	10.33	12.67	7.33	15.79^{bc}	-0.04	0.17	1.12	0.68	0.91
Mean	41.41^{a}	33.18^{b}	26.92^{c}	22.01^{d}	15.87^{e}	11.23^{f}						

characters in high saline environments relative to low saline environments. In the present study, we have assessed the salinity tolerance of cultivars using the concepts of both stress susceptibility index at each higher salinity level in relation to the control and the mean value over the salinity treatments with respect to each character. We selected the most tolerant cultivars considering the information of all the characters under study. Among test cultivars, tolerance to different salinity levels has been found consistent for traits like plant height and number of tillers, especially at higher levels of salinity (Tables 3 and 4). Similar observations have been made in wheat (Nadaf *et al.,* 2001) and in perennial rangeland and forage grass species (Nadaf *et al.,* 2004).

Among all the cultivars tested, the salinity tolerance of J-136 was higher and more consistent as it scored low values of stress susceptible index under high salinity levels in respect of all the four characters studied, viz. plant height, number of tillers, green matter and dry matter yield. It also had high mean values for three characters, viz. plant height, number of tillers and green matter yield. All other cultivars, however, responded differentially to different levels of salinity for different characters.

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