The effect of salinity on germination , growth characters , and emergence of barley *Hordeum vulgaris* L. in different soil textures.

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Abstract

Laboratory experiment in Petri dishes was conducted to study the effect of different salt concentration levels (3,6,9,12 and 15)dS/m of NaCl, and to distill water treatment as acontrol, on germination percentage of barley seeds The results showed an increase of salt concentration levels(6,9,12 and 15) dS/m causing adecrease in germination percentage (2%,3%,5%, and 8%) respectively, the length of plumule and radicle of seedling and their dry mater weight decreased too.Other two experiments in plastic pots were adapted to study the effect of the salt at the same concentration levels on growth , percentage and rate of emergence. The results showed that the growth in terms of stem, length and their dry matter weight and the percentages of emergence were decreased , as aresult of the increase of salt concentration levels at different soil textures whereas the mineral contents were increased.

Introduction

The problem of soil salinity which particulary appears in the course of irrigation, leading from seriously diminished yield to complete loss of land suitability, has amajor importance in many areas with arid and semi arid climatic conditions(Doering *et al*. ,1984). Soil salinity is recognized as an important problem in agriculture of south Iraq (Al-Zubaydi and Al-Seedi,1999). Most of crops are very sensitive to salinity,their growth being severely inhibited by sodium chloride concentrations(Al-Zubaydi *et al*. , 1992). Non halophyte growing in saline environment is only within limits able to regulate their intercellular ionic composition in order to prevent growth reduction (Rathert and Doering, 1981). Crops have awide range of tolerance to salinity , the differences among plants are mainly dependent on differences in osmoregulation , especially at high external salt concentration (Hellebust , 1976) and on differences in ion uptake by the roots and translocation in to the shoots in response to the nature of salinization (Greenway

and Munns, 1980). In most works , salt tolerance is correlated within the ability to regulate the Na and Cl uptake and translocation in response to growth reduction (Flowers *et al*.,1986 ; Flowers *et al*.,1990). Under saline conditions, depression of germination percentage usually takes place by the companied effect of seed absorption capacity as aresult of high osmotic pessure of the soil solution (Dutt,1976) and specifically ion effect (Hassen , 1999). Increasing salt concentrations reduced the germination percentage of many crops were reported by many authers (Al-Zubaydi *et al*., 1992 ; Nasir , 2002 ; Al-Seedi , 2004).

The main response of plants to salinity is reflected on growth rate reduction.

Nasir (2002) foundthat increasing salinity caused adecrease in germination percentage , length and dry matter weight and increasing the ions concentration (Na,Ca and Cl) of radicle and plumule of three varieties of wheat . The depression of plant growth under saline conditions have been widely investigated (Al-Zubaydi, 1994 ; Al-Zubaydi and Al-Seedi, 1999 ; Al-Seedi ,2004). The dry weight of shoots and roots were decreased with increasing salinity on barley (Mozafar and Oertli,1990) and wheat Nasir(2002). The ionic content of shoots and roots depends on the concentrations of salts in the extxrnal medium in which plants were growing . The increase of ionic content of many plants was reported by many authers (Jenson , 1982 ; Flowers *et al*., 1991 ; Nasir , 2002).

The quality of irrigation water was one of the main factors which affects the agriculture production , in addition of the direct effect growth and yield of cereal crops , also it affected the capacity of the soil production and caused achanges in their physical and biochemical properties (Abood and Esmail , 1988).

Soil salinity was considared as alimiting factors which affected the percentage and a rate of emergence of barley plant. Sorour *et al*.,(1977) found that the irrigation with saline solution decreased the emergence percentage of three wheat varities. Soil textures differ from their ability to conserve the moisture and their ability to conformation the crust and other difference which were affected the percentage and a rate of emergence (Al-Gubori *et al*.,1988).

The aim of the present study was to investigate the effect of different salt concentration levels on germination , growth and emergence of the local variety of barley plants and the ionic contents of soils.

Materials and Methods

Seeds of barley were surface sterilized with 5% of sodium hypochloride solution for 5 minutes and washed with distilled water before utilization in the experiment . Salt solution was prepared to give the concentration levels(3,6,9,12 and 15) dS/m of NaCl, in addition to distilled water treatment was applied as acontrol. Twenty five seeds were germinated in each one of four Petri dishes (10 cm.diam.) used in each treatment. Afilter paper was put in each dish and moistened with 5 ml. of salt solution and incubated at 25 c̊ . After 5 days germinated seeds were recorded and the percentage of germination was calculated (The percentage transformed to arcsine for statistical analysis). The length of plumule and radicle of seedling were measured and separated from the contact point and dried on an oven at 70c̊ for 48 hours. The second experiment was carried out using aplastic pots (18 cm. diam.) containing 2kg of sandy loam soil with EC(4.2dS/m) , pH(7.2) , clay loam

soil with EC (4.5dS/m),pH (7.3) and amixture of two soils in the percent (1:1) .Treatments were replicated three times .Salt solution was prepared to give the same concentration levels, and was added as an irrigation water to plastic pots, in addition to tap water treatment was applied as acontrol. Healthy seeds were chosen and then 10 seeds were sowed in each plastic pot at a depth 1 cm. At the first experiment , pots were irrigated with tap water up to soil field capacity till the seedling reached 10 days old and then thinned to 5 plants. These plants had received the salt concentration levels for aperiod of 15 days , then the stem length (cm.) of plants was measured and harvested , shoots were washed and dried in an oven at 70c̊ for 48 hours. The dry matter was calculated by balance (Mettler-Pl-200).The dry matter was digested according to the procedure described by (Cresser and Parsons , 1979) for analysis of the ionic content.Sodium was determined by flame photometer, Calcium by atomic absorption spectrophotometry(Pye unicam SP 800) and chloride was determined according to the procedure described by (Al-Musawi , 1977). The ions were calculated by mg/gm dry weight .

The ionic content of soils were determined from the extract (water to soil) in the ratio (2:1) , (EC) was measured , in addition to tap water treatment used as acontrol in the thrid experiment also. Pots had recieved the salt solution treatment directly for aperiod of seven days , after seven days of sowing the percentage of emergence was calculated , the number of seedling also was recorded daily till the end of the experiment to calculate the rate of emergence according to the equation :

$$\text{The rate of emergence} = \frac{(\text{summation of increasing at number of emergence seedling at day})}{\text{number of days of sowing}}$$

(Al-Gubori et al. , 1988). The obtained data were subjected to statistical analysis of variance and the T. Values at 0.05 level of significance were calculated.Test of significance was done according to the revised L.S.D. test for each salt treatments (Al-Rawi and Kalaf-Alah , 1980).

Results and Discussions

Table (1) showed that high (100%) and low (92%) of germination percentage occurred at salinity treatmenet (3 and 15) dS/m as compared with a control in distill water . Germinaiton was affected by the increasing of salinity concentration level 3 dS/m of salinity . Agradual decrease obtained in germination percentage of salinity increasing from 3 to 15 dS/m. Germination percentage reduction by increasing salinity was commonly attributed to adirect toxicity of an ion or ions (Flowers *et al*., 1990) . These results were in accordance with many authers(Al-Zubaydi *et al*., 1992 ; Hassen , 1999 ; Al- Seedi , 2004).

The increase of salinity causes adecrease in the lenghth of radicle and plumule and their dry matter weights. There were a gradual decrease with the increasing of salinity concentration levels were noticed. From a ratio (P/R)it was clearly thatsalinity affected both plumule and radicle and the effect was in balance .Significant differences between concentrations were in accordance with many authers (Flowers *et al*., 1991 ; Nasir , 2002 ; Al-Seedi , 2004) that increasing concentration of salinity causes adecrease in the growth of plants.

Table (1) The effect of salinity on the percentage of germination , length of plumules and radicles and their dry matter weights(5 plants)

Salt treatment dS/m	Percentage of germination	arcsine	Plumules		Radicles		P/R weight
			length (cm)	dry weight (mg)	length (cm)	Dry weight (mg)	
control	100	a 90.0	a 6.0	a 28.82	a 7.63	a 20.27	a 1.42
3	100	a 90.0	a 5.70	a 27.39	a 7.52	a 19.78	a 1.38
6	98	b 81.87	4.18	b 21.35	b 6.36	b 17.32	b 1.23
9	97	b 80.0	3.65	c 17.63	c 5.29	c 14.53	b 1.21
12	95	c 77.08	2.72	d 13.52	d 3.44	d 11.28	b 1.19
15	92	c 75.57	1.93	e 9.36	d 3.05	e 8.22	c 1.13
R.L.S.D.		2.42	0.68	3.24	0.76	2.0	0.05

** Each number resemble the mean of 5 plants.*
** Numbers having the same letters are not different at 0.05 level of significance.*

Table (2) revealed that the effect of salinity on the length and dry matter weight of barley at different soil textures. It was evidently , that salinity affected the length and the dry matter weight of the plant . Significant differences between salinity concentrations were occurred. The growth reduction is caused by salinization due to alimitation of water supply(Yeo *et a*l.,1991) and growth declined as ion accumulation increases(Cuartero *et al*., 1992) or perhaps growth reduction is due to several cytoplasmic and chloroplastic enzymes could not function well in high salinity (Hajibagheri *et al*., 1993). It was clear that salinity affected the plant length and the dry matter weight at different soil textures , but the highest reduction was noticed at clay loam soil, it was due to the decrease of the available of soil water or the applied of salinized water caused the releaseof bound ions especially Na , the increasing concentration of Na in the plant growth medium caused reduction in plant selective ability to absorb other important ions especially K ions resulted in atoxic accumulation of Na ion in plant tissue(Torres , 1972).

The accumulation of toxic ions within plant also cause anutritional imbalance lead to growth reduction (Al-Zubaydi and Al-Seedi , 1999).

Table (3) demonstrated the effect of salinity concentration levels on the ionic content of barley plant at different soil textures. The ionic content was increased on the shoot in aconsequence of increasing salinity concentrations levels at different soil textures. Significant differences (P 0.05) between all concentrations occur as

Table (2) The effect of salinity on the length (the mean of 5 plants) and the dry matter weight (5 plants/pot) at different soil textures.

salt treatments dS/m	plants length(cm.)			dry matter weight(mg/pot)		
	sandy loam	clay loam	amixture	sandy loam	clay loam	amixture
control	a 15.0	b 14.28	ab 14.65	a 274	a 277	a 272
3	c 12.85	d 11.71	d 12.24	b 246	b 237	b 241
6	e 9.70	f 8.92	f 9.10	c 195	d 182	cd 189
9	g 7.58	ghi 7.14	gh 7.25	e 156	fg 146	ef 153
12	hij 6.85	j 6.42	ij 6.67	gh 140	i 129	hi 134
15	k 5.78	k 5.35	k 5.50	j 118	k 102	k 107
R.L.S.D.		0.54			9.72	

Table (3) The effect of salinity on the ionic content in shoots of barley (mg/gm dry weight) at different soil textures.

salt treatments dS/m	sandy loam soil Ions					clay loam soil Ions					amixture of soils Ions				
	Na	Ca	Mg	K	Cl	Na	Ca	Mg	K	Cl	Na	Ca	Mg	K	Cl
control	g 6.5	k 8.2	m 10.0	b 13.2	j 2.9	g 6.9	j 8.9	ki 10.8	a 14.0	i 3.7	g 6.7	j 8.6	l 10.5	ab 13.7	ij 3.2
3	f 8.8	i 9.3	jk 11.2	c 11.8	h 4.8	f 9.3	h 9.7	i 11.7	c 12.2	g 5.6	f 8.9	hi 9.5	ij 11.3	c 11.9	gh 5.3
6	e 10.7	g 10.2	h 12.7	e 9.2	f 6.7	e 11.2	f 11.3	fg 13.2	d 10.3	ef 7.2	e 10.9	g 10.5	gh 12.9	d 9.8	f 6.8
9	d 12.6	f 11.2	f 13.4	f 8.5	de 7.9	d 13.2	e 11.7	e 13.9	e 9.1	d 8.8	d 12.8	ef 11.4	ef 13.6	ef 8.8	d 8.4
12	c 15.2	d 12.5	d 15.3	h 6.7	c 9.5	c 15.8	c 13.0	c 15.8	g 7.4	c 10.0	c 15.4	cd 12.8	cd 15.5	h 6.3	c 9.7
15	b 19.8	b 13.7	b 16.6	j 4.9	b 11.2	a 20.8	a 14.2	a 17.2	i 5.2	a 12.2	b 20.0	b 13.8	a 16.8	j 4.6	b 11.6

R.L.S.D. Na = 0.77 Ca = 0.34 Mg = 0.40 K = 0.52 Cl = 0.50

Compared with control. An increase in salinity leads to increase the concentrations of ions (Na,Ca and Cl) in shoots and roots of plant (Flowers *et al*.,1991).

The increasing in ionic accumulation in shoots of plant perhaps was due to the quantity of salt that was added. An increase in the concentration of an ion in the

external medium of growth leads to absorption of ion by plant (Change and Dregne , 1955). The presence of sodium ion in roots medium leads to increase the membranous permeability of roots , thus the ions were increased (Greenway and Munns , 1980).

Table (4) revealed the effect of salinity on the concentrations of ions at different soil textures. It was noticed that the concentration of ions were increased with increasing salinity and there were significant differences (P 0.0.5) occurred between treatments at all soils and also,signficant differences (P.0.0.5) were observed between soils .The increased of salinity in irrigated water leads to agradul increase in soil salinity (Al-Saadi *et al*., 1982). The high saline irrigated water caused the release of bound ions of the soil granules or perhaps the increasing salinity of soil due to the nature and motion of salt ions , and the reasons of increase on ions concentration of soil solutions were irrigated with high saline water causes the dissolve of some salts(Al- Seedi , 1992). The differences between soils at their ionic contents were perhaps due to the differences in their chemical and physical properties thus , the differences between soils were observed . It was evident that , salinity affected the percentage and arate of emergence , with increasing salt concentration levels.

Table (4) The effect of salinity on the concentration of ions at different soil textures

salt	concentrations of ions														
treatments	sandy loam					clay loam					amixture				
dS/m	Na	Ca	Mg	K	Cl	Na	Ca	Mg	K	Cl	Na	Ca	Mg	K	Cl
	i	m	j	i	k	j	k	gh	j	ij	k	l	i	k	jk
control	10	6	5	4	9	14	11	9	6	13	12	8	7	5	11
	j	i	hi	j	ij	h	ij	ef	g	h	i	jk	fg	i	i
3	15	9	8	6	13	23	13	11	9	17	18	12	10	7	14
	i	jk	fg	h	h	f	fg	d	e	ef	g	hi	e	g	g
6	19	12	10	8	17	29	16	14	11	28	26	14	12	9	22
	h	gh	e	g	f	e	de	c	d	cd	f	fg	d	f	ef
9	24	15	12	9	26	32	18	17	12	35	30	16	14	10	28
	f	ef	d	f	e	c	c	b	b	b	d	d	c	e	d
12	29	17	14	10	29	37	21	20	14	40	35	19	17	11	34
	d	c	c	d	c	a	a	a	a	a	b	b	b	c	b
15	35	21	18	12	37	44	25	24	15	46	40	23	21	13	42
R.L.S.D.	Na = 1.89			Ca = 1.16			Mg = 1.27			K = 0.62			Cl = 2.17		

Table (5) demonstrates the effect of salinity on the percentage and a rate of emergence of barley seedling at three soil textures. Agradual decrease was noticed at all salinity treatments except 15 dS/m. The highest reduction was observed at high salinity concentration levels 15 dS/m as compared with the control , asignificant

differences (p 0.05) between all salinity treatments also occurred .The reduction on percentage and a rate of emergence by increasing salinity was attributed to the increase of osmotic potential of soil solution (Al-Seedi , 2004) or perhaps accumulation of salts causes adecrease in available water (Nasir , 2002).

McGinnes (1960) referred to an adverse relationship between soil moisture stress and percentage of emergence. The increase of salt concentration levels caused areduction in the available water for absorbing by seeds, and reduced the

Table (5) The effect of salinity on the percentage and the rate of emergence of barley plant.

salt treatments (dS/m)	percentage of emergence: sandy loam Per.	sandy loam Arc.	clay loam Per.	clay loam Arc.	amixture Per.	amixture Arc.	the rate of emergence: sandy loam	clay loam	amixture
Control	100	90 a	100	90 a	100	90 a	5.24 a	4.95 a	5.10 a
3	100	90 a	98	78.52 b	99	84.26 b	4.12 b	3.89 b	3.98 b
6	92	73.57 c	83	56.10 d	89	70.63 c	3.27 c	2.88 d	3.17 cd
9	78	51.26 d	72	46.05 e	75	48.59 e	2.19 e	1.97 e	2.10 e
12	52	31.33 f	46	27.38 f	49	29.34 f	1.34 f	0.87 g	1.14 fg
15	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
R.L.S.D			5.86					0.291	

percentage of soil moisture (AL-Seedi , 2004). Edward and Hartwing (1971) reported that the increase of soil moisture percentage caused an increase in the percentage of emergence. Agradual decrease on the percentage and a rate of emergence by increasing salt concentration levels was due to agradual decrease of water potential between seeds and soil , which caused adecrease on the water entrance to seeds , there fore , the water content of embryo was reduced .Al-Seedi , 2004). The reduction on water content caused an imbalance in physiological activities and chemical translocation which accompanied the germination and emergence especially enzymes that stimulated the embryo for germination (Street and Oipk , 1979) .

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تأثير الملوحة على الأنبات وصفات النمو والبزوغ لبادرات الشعير في الترب مختلفة النسجة

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الخلاصة:

أجريت تجربة مختبرية بأطباق بتري لدراسة تأثير مستويات لتراكيز ملحية مختلفة (٣،٦ ، ٩، ١٢ و ١٥) ديسيمنز / مترمن ملح كلوريد الصوديوم والماء المقطر كمعاملة سيطرة على نسبة الأنبات لبذور الشعير. أظهرت النتائج إن زيادة مستويات تراكيز الملح (٦ ، ٩ ، ١٢ و ١٥) ديسيمنز/ متر سببت إنخفاض في نسب الأنبات (٢% ، ٣% ، ٥% ، ٨%) على التوالي وكذلك طول الرويشة والجذير للبادرات والمادة الجافة لهما. وأجريت تجربتان في سنادين بلاستيكية خصصت لدراسة تأثير الملح بنفس مستويات التراكيز الملحية على النمو ونسبة ومعدل البزوغ .أظهرت النتائج إن النمو وكما هو مقاس في طول الساق والمادة الجافة لـه ونسب البزوغ إنخفض بزيادة الملوحة كنتيجة لزيادة مستويات تراكيز الملح في مختلف نسجات التربة في حين إزداد المحتوى المعدني للنبات والتربة معاً.