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Effect of Sodium chloride concentrations on the Growth and Some Organic Chemical Compounds of Barley *Hordeum vulgaris* L.

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Abstract

An experiment in plastic pots was conducted to know the effect of different salt concentration levels (3 , 6 , 9 and 12) ds/m of sodium chloride in addition to distill water as a control treatment on the growth and some organic chemical compounds of barley plant (local variety) cultivated in Iraq . The results of the study shows an increase on the salt concentration levels causing a gradual decrease on the growth of plant in terms of stems heights (11.5-4.3 cm), water content percentages (87.6-85.0 %) and dry matter weights at the all salinity treatments as compared with distilled water at a control treatment , and increasing in the carbohydrates (1.5- 2.5 µg/gm), proteins (12.3-15 µg/gm) and proline (7.8-12.4 µg/gm) concentrations whereas the different patterns of a significant differences were observed between the all salinity treatments .

Key Words : Sodium chloride concentrations , Carbohydrate , Proteins , Proline .

Introduction

It is well documented that the amount and quality of irrigation water available in many of the arid and semi arid zones of the world are the main limiting factors to the extension of agriculture (Beck , 1984 ; Munns , 2002).

Saline - sodic irrigation water , coupled with the low annual rainfall and high evaporation and transpiration in the arid and semi - arid regions , have resulted in accumulation of soluble salts in the soil solution and of cations (especially sodium ions) on exchange sites , which can alter the structure and , consequently , affect the soil hydraulic conductivity (Sameni and Morshedi , 2000) . The build up of sodium salts in irrigated regions is of particular concern since (14 %) of cultivated land that is irrigated supplies approximately half of the world's food (Christiansen , 1982). This has prompted researchers to study the impact of salinity on field crops . Several studies showed external signs of salt toxicity due to irrigation with saline water such as sclerosis , leaf burning and poor vegetative growth (Flowers *et al.* , 1977 ; Adler and Wilcor , 1987). Soil salinity was recognized as an important problem on the southern region of Iraq where barley was widely grown (Al - Zubaydi and Al - Seedi, 1999) . A reduction of the plant growth correlated with the increase of salinity which causes a decrease in stem height , shoot dry matter weight of many wheat varieties (Kumar *et al.* ,1987) and a number of branches and spikes of barley (Al - Zubaydi and Al - Seedi , 1999) . The tolerance of plants to salt stress leads to the accumulation of some compatible osmotic organic solutes as carbohydrates , proteins , amino acids , especially proline , betaine , sugar , ammonium compounds and polyols which are important on the osmoregulation (Gorham *et al.* , 1981 ; Bolarin *et al.* , 1995 ; Saffan , 2008) . The compatible osmotic compounds played an important role to conservation the inner cellular structures , and decrease the harmful of oxidation (Rhodes and Hanson , 1993) . the present investigation was , therefore undertaken to study the effect of sodium chloride on the growth and chemical compounds of barley plant .

Materials and Methods

The experiment was carried out during the growing season of (2008 – 2009) in the garden of Biology Department from (10) November to (10) December (2009) . Salt solution was prepared by the dissolving 1.82 , 3.84 , 5.76 and 7.68 gm NaCl / L to give electrical conductivity levels (3 , 6 , 9 and 12) ds / m of NaCl , in addition to distilled water as a control treatment . Treatments were replicated three times . Salt solution was added as an irrigation water to plastic pots, containing (0.5) Kg . of sandy loam soil with EC (3.7) ds / m and pH (7.3) . Healthy seeds of barley plant were chosen , then (10) seeds were sown in each plastic pot . Pots were irrigated with distilled water up to soil field capacity till the seedling reached (10) days age , then these plants had received the salt solution for the remained periods of the experiment . The stems heights were measured and then plants harvested . Shoots were washed by distill water , the fresh weight was measured , and the samples were prepared to the estimation of soluble carbohydrates and protein , then dried in an oven at (65) $^{\circ}$C for 48 hours , the

dry weight was measured , and then material was ground into a fine powder to the estimation of proline .

A-Estimation of total soluble carbohydrates and proteins

Total soluble carbohydrates and proteins were estimated according to the procedure described by Herbert *et al*. ,(1971) . (200) mg of fresh weight of the shoot system was taken and crushed with (10) ml of distill water , the extract was centrifuged for 15 minutes , the clear solution was heated in water bath at (50) ◌̊C for 30 minutes , then centrifuged again for 15 minutes . The clear solution obtained was measured by spectrophotometer (Spectro SC Labomed Inc. USA) at the wavelength (490) nm. for glucose and (600) nm. for proteins .

B-Estimation of proline

1- Preparation of the proline standard calibration curve

A standard curve was prepared from different concentrations ranged from (1 - 10) mg / l by using of the pure proline (100 mg) was dissolved in liter of a distill water . From each concentration (3 ml) had taken and put in a test tube , (3 ml) of a glacial acetic acid and (5 ml) of ninhydrin were added and mixed . The mixture was heated in a water bath at boiling point for 30 minutes , then elicit and let to cool (5 ml) toluene was added to the mixture and let for 10 minutes . The optical densities for the different concentrations of the pure proline (1 , 2 , 3 , 4 , 5 , 6 , 7 , 8 , 9 and 10 mg / l) were measured at a wave length of (520) nm, the results were recorded and the standard curve was done (Diagram -1-).

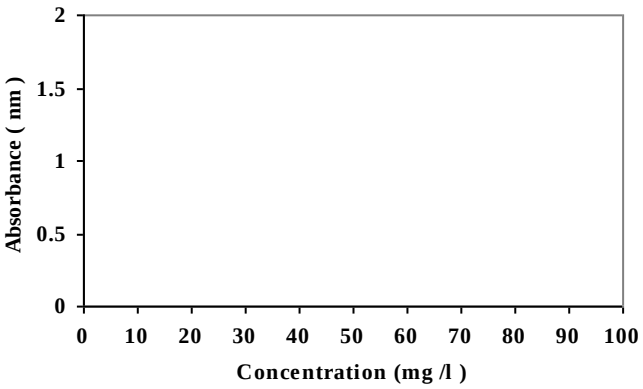

Diagram (1) proline standard calibration curve

2 - Estimation of proline

The ground dry matter (100 mg) had been taken and put into conical flask , then (5 ml) of sulfosalsalic acid (3%) was added . The mixture was put in marked test tubes and centrifuged by a centrifuge model Fanem Excelsa II Mod. 206 BL. at (3300) circle for 5 minutes , after that clear extract was transformed to new test tubes and mixed with (3 ml) of a glacial acetic acid and (3 ml) of ninhydrin acid . Test tubes were put in a water bath at boiling point for 30 minutes , then elicited and cooled , the red colour noticed was due to the reaction of proline with ninhydrin acid which was separated by adding (5 ml) of toluene . Red toluene layer was measured by spectrophotometer at the wave length (520 nm). and the results were recorded . The obtained data were subjected to statistical analysis of variance and the (t) test values at (0.05) level of significance were calculated . Test of significance was done according to the least significant differences(L.S.D.) for each salt treatment by using the statistical program (Spss - 11- 2003).

Results and Discussion

Table (1) shows the effect of NaCl concentration on the growth of barley plant . The growth was significantly affected by the increase in salinity levels . Salt free solution revealed the highest plant growth , whereas the lowest growth was observed under (12) ds/m treatment of salinity . A gradual decrease of growth was obtained with increasing salinity from (3 - 12) ds/m . From the table (1) it was clear that the height , water content and dry weight of plant was negatively affected .The growth reduction was caused by salinization due to a limitation of water supply (Yeo *et al.* , 1991) or due to toxic effect (Hassen,1999). The growth reduction is due to several cytoplasmic and chloroplastic enzymes could not function well in high salinity (Hajibagheri *et al.* , 1993) . In addition , plants growing in saline medium spend high energy to balance its osmotic potential on the expense of energy required for normal growth and physiological activities (Flowers *et al.* , 1986) .

Table (-1-) The effect of salinity on the growth of barley plant (plant / pot) .

Salt treatments (ds / m)	Mean of the plant lengths(cm)	Water content (%)	Dry matter (gm / pot)
Control	*a* 11.50	*a* 87.64	*a* 14.96
3	*b* 9.50	*b* 86.41	*a* 14.53
6	*cd* 7.40	*b* 86.36	*b* 13.59
9	*d* 6.25	*c* 85.47	*b* 13.46
12	*e* 4.30	*c* 85.04	*c* 12.36
Means	*c* 7.79	*b* 86.184	*b* 13.78
L.S.D.	1.44	0.52	0.514

* Numbers followed by the same alphabetical letters are not significantly different from each Other at (0.05) level of significance.

Table (2) shows the effect of NaCl concentration on the total soluble carbohydrates , proteins and proline on the shoot system of barley . A gradual increase was noticed as the salinity increases. There were different patterns of significance (P 0.05) occurring between salinity treatments . These results are in accordance with many authors (Rakova *et al.* , 1969; Gorham *et al.* , 1981; Serrano *et al.* ,1999) . The

low concentrations of carbohydrates , proteins and proline (1.50 , 12.30 and , while the high concentrations (2.50 , 15.0 and 12.40 µg / gm)
, while the high concentrations (2.50 , 15.0 and 12.40 µg / gm) were noticed at the salt treatment (12) ds/m. The incurrence of plants to the salt stress leads to the accumulation of some organic solutes such as carbohydrates , sugar and proline , these compounds are important for plants on the osmoregulation (Gorham *et al*., 1981) . The response of plants to the osmotic stress was based on the construction process on the number of the defense proteins , the plants defense against the affect of salinity by the osmoregulation process which continues by the biosynthesis of the solutes on the cells (Serrano *et al*. , 1999). Increasing salinity on the growth medium of the plants leads to an increase on the 7.80 µg / gm) , respectively occurred on the distill water at a control treatment absorbance of some essential elements that activated the action of some enzymes , which were essential for the protein biosynthesis (Rakova *et al*. , 1969) . Increase of proline concentration on the tissues of plants that grows in saline environment was resulted from the imbalance on the osmoregulation inside the cells that was due to the increases of salts on the growth medium , these increases of proline concentrate on the cells to a creation the case of osmotic balance inside the cells especially between vacuoles and the cytoplasm (Naidu , 2003) . The important properties of salinity was the effect of the dominance of proteins and some of amino acids , especially proline on the plants , these organic compounds increased according to the increase of salinity (Abo - Zaid , 2000) .

Table (2) The effect of salinity on total soluble carbohydrates, proteins and proline on the shoot system of barley plant.

Salt treatments (ds / m)	Carbohydrates (µg / gm)	Proteins (µg / gm)	Proline (µg / gm)
Control (D.W)	*d* 1.50	*c* 12.30	*c* 7.80
3	*cd* 1.70	*c* 12.50	*b* 10.60
6	*bc* 1.80	*c* 12.60	*b* 10.80
9	*a* 2.30	*b* 13.50	*a* 11.90
12	*a* 2.50	*a* 15.0	*a* 12.40
Means	*b* 1.96	*b* 13.18	*b* 10.70
L.S.D.	0.20	0.54	0.92

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تأثير تراكيز مختلفة من كلوريد الصوديوم على النمو وبعض المركبات الكيميائية العضوية في نبات الشعير (*Hordeum vulgaris* L .)

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البصرة - العراق

الخلاصة

أجريت تجربة في أصص بلاستيكية لمعرفة تأثير مستويات تراكيز مختلفة من الملوحة (3 و 6 و 9 و 12) ديسيسمنز / م من كلوريد الصوديوم بالإضافة إلى الماء المقطر كمعاملة سيطرة على النمو وبعض المركبات الكيميائية العضوية في نبات الشعير (صنف محلي) منزرع في العراق .

أظهرت نتائج الدراسة إن زيادة تراكيز مستويات ملح كلوريد الصوديوم سببت انخفاضاً تدريجياً في نمو النبات متمثلاً بأطوال السيقان (4.3 – 11.5) والنسبة المئوية للمحتوى المائي (85.0 – 87.6) والمادة الجافة التي تراوح انخفاضها من (12.3 – 14.9) غم / اصيص في جميع المعاملات الملحية مقارنة بمعاملة السيطرة بالماء المقطر مع زيادة في تراكيز الكاربوهيدرات (1.5 – 2.5) مايكروغرام / غرام والبروتينات (12.5 – 15) مايكروغرام / غرام والبرولين (7.8 – 12.4) مايكروغرام / غرام , كما لوحظت طرز مختلفة من الفروق المعنوية بين المعاملات الملحية كافة .