ISSN 1991- 8690 الترقيم الدولي ٨٦٩٠ - ١٩٩١
Website: http://jsci.utq.edu.iq Email: utjsci@utq.edu.iq

Effect of salinity on Seed Germination and Growth of Tomato Seedlings (*Lycopersicon esculentum*)

Karima F. Abbas

Department of Biology -College of science -Basrah University

Abstract

This study was conducted in a private orchard during growing season 2009 to investigate the effects of NaCl application on growth of Tomato (*Lycopersicon esculentum*). The Saline water used was prepared in Six concentrations namely (0, 1000, 2000, 3000 ,4000 and 5000 ppm) .This study was evaluated in Two steps, seed germination and plant growth. The result showed that salinity caused a delay in seed germination and reduce the number of germinated seeds .At higher NaCl concentration(5000 ppm) , No seed germination was observed. Chlorophyll content & leaf area decreased with increasing salinity. The plant height decreased with increasing salinity. plant fresh and dry shoot and root weights were decreased with increasing salinity. Increasing salinity levels in the water significantly decreased the content of N,K in leaves, and non decreased of P, and increased the content of Na .

INTRODUCTION

Salinity is considered to be one of the major factors that limit crop productivity in arid and semi-arid countries(Szabolcs, 1994). Salt water in the root zone induces osmotic changes and interferes with nutrient uptake (Cornillon and Palloix, 1997; Halperin *et al.*, 2003). Salt accumulated in the plants may inactivate plant enzymes (Flores *et al.*, 2000) and disrupt osmotic adjustment at the level of cytosol and vacuoles (Apse *et al.*, 2002). Physiological and molecular responses of plants to salt stress have been extensively studied, while the underlying mechanisms are still not well understood (Hasegawa *et al.*, 2000). The buildup 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 plant Crops. Several studies showed external signs of salt toxicity due to irrigation with saline water such as sclerosis, leaf burning and poor vegetative growth (Gornat et al., 1973; Flowers et al., 1977; Adler and Wilcor, 1987).

Examining plant growth during the whole growing season provides information about crop salt tolerance over time. Plant response to salinity changes with age, plant development and growth stage (Maas, 1993). For example, Del Amor *et al.,* (2001) reported that tomato plants are more sensitive during the seedling stage than during later stages of growth. Relative growth rate allows one to make more appropriate comparisons of plant growth among salinity treatments than absolute growth rate (Cramer *et al.,* 1994).

Tomato is one of the important and widespread crops in the world, and it is moderately sensitive to salinity (Ayers and Westcot, 1985) , since it can tolerates an EC of the saturated soil extract up to about 2.5 dS/m without any yield reduction and fruit yield decrease by 10% with each unit of EC increasing above the threshold value (Maas, 1986). Large amount of laboratory research and on-farm applied and adaptive research activities on tomatoes have been executed under saline water by numbers of researchers in many different countries.

The effect of salinity concentration on plant growth has been studied in different tomato cultivars. Adler and Wilcor (1987) found that salinity adversely affected the vegetative growth of the tomato, and it reduced plant length and dry weight. Salinity also reduced the fresh and dry shoot and root weight of tomato (Shannon *et al.,* 1987). Increased salinity over 4000 ppm led to reduction in dry weight, leaf area, plant stem, and roots of tomatoes (Omar *et al.,* 1982).

The reduction of dry weights due to increased salinity may be a result of a combination of osmotic and specific ion effects of Cl and Na (Al-Rwahy, 1989). The leaf and stem dry weights of tomato were also reduced significantly in plants irrigated with saline nutrient solution in contrast with control plants (Satti and Al- Yahyai, 1995). Byari and Almaghrabi (1991) found that tomato cultivars varied greatly in their response to different salinity levels. Increasing NaCl concentration in nutrient solution adversely affected tomato shoot and roots, plant height, K concentration, and K/Na ratio (Al- Karaki, 2000).

Since the increasing of water salinity in studying region at Abu-alkassib province south of Basrah of Iraq which used for irrigation , and tomato (*Lycopersicon esculentum*) is a major food plant, for that reasons, the extensive research is necessary to develop growing conditions in moderate salinity to produce good vegetative growth and to provide further insight into the salt effects on plant growth.

MATERIALS AND METHODS

The experiment was conducted at Abu-alkassib province south of Basrah of Iraq during the spring growing season (2009). This study consist of two parts The effect of salinity concentration on germination and seedlings growth .The Seeds of tomatoes (*Lycopersicon esculentum Mil, c.v.* super marmand) were placed in Petri dishes (50 seed / Petri dish) and moisten with salinity treatments(NaCl) (0,1000, 2000, 3000,4000,5000 ppm) the germination rate was documented after eight days. For studying the effect of salinity on seedlings growth The seeds were sown on february15th 2009 in Plastic pots 3.5 kg Capacity were filled with a mixture of field soil and peat moss (1:1 volume basis). The seeds were irrigated with tap water until the first true leaf stage appeared, after that The seedlings, with almost the same stem thickness and vegetative growth were selected to the experiment, A randomized Complete blocks design with four replicates were used statistically analyzed using RLSD Test at 5 % level according to the Al-Rawi & Khalaf-Allah, (2000), Five weeks-old seedlings The control plants were irrigated with tap water while the others were irrigated with these salinity treatments (0,1000, 2000, 3000,4000,5000 ppm). there were six treatments, and four replicates. Plants height were documented ,chlorophyll content were documented according to Zaehringer *et al*.(Abbas & Abbas ,1992),To represent the vegetative growth just before flowering stage, the seedlings samples were separated to shoots and roots to evaluate their fresh and dry weights.. Samples being then grinded and digested for assayment of Nitrogen by the Micro-Kjeldahl method (Bremner and Mulvaney, 1982), potassium as well as sodium by flame photometer, Phosphor by spectrophotometer(Jackson,1958).

RESULTS AND DISCUSSION

Salinity is currently one of the most severe a biotic factors limiting agricultural production. Salinity of soil and water is caused by the presence of excessive amounts of salts. Most commonly, high amount of Na+ and Cl^- cause the salt stress. Salt stress has three fold effects which reduces water potential and causes ion imbalance on disturbances in ion homeostasis and toxicity.

1- Seed Germination

The results show that the seed germination decreased with increasing of NaCl concentration (Table 1) . Increasing salinity levels caused delay in seed germination while some seeds did not germinate at all especially at the highest concentration.

The effect of the external salinity on the seed germination may be partially osmotic or ion toxicity which can alter physiological processes such as enzyme activation which reduce cell division and plant growth metabolism (Begum et al., 1992; Croser *et al.,* 2001; Essa and Al-Ani, (2001), According to Ashraf *et al.,* (2003), NaCl has an inhibitory effect on seed germination and its effect on germination showed time – course dependence for absorption of Na and Cl by the hypocotyls

Table 1. Daily Seed Germination (seed number) starting from 8th day of experiment starting .

NaC / da	Control 0 ppm	1000 ppm	2000 ppm	3000 ppm	4000 ppm	5000 ppm
8th	6	_	_	_	_	_
9th	9	_	_	_	_	_
10th	10	_	_	_	_	_
11th	10	_	_	_	_	_
12th	40	_	_	_	_	_
13th	44	8	_	_	_	_
14th	44	18	_	_	_	_
15th	44	18	1	1	_	_
16th	44	19	3	2	2	_
17th	44	20	6	4	3	_
18th	44	23	17	5	3	-
19th	48	32	19	7	4	-
2oth	48	32	27	11	4	-

2- chlorophyll content

The total chlorophyll content decreased with increasing of NaCl concentration (Figure 1).The highest chlorophyll content was in control plant, while the lowest content was in plants grown under salinity stress (highest concentration of NaCl).The chlorophyll contents in different tomato cultivars decreased by NaCl stress (Khavarinejad and Mostofi,1998) The decreased in chlorophyll content under salinity stress is a commonly reported phenomenon and in various studies, because of its adverse effects on membrane stability (Ashraf and Bhatti, 2000; Al-Sobhi et al., 2005).

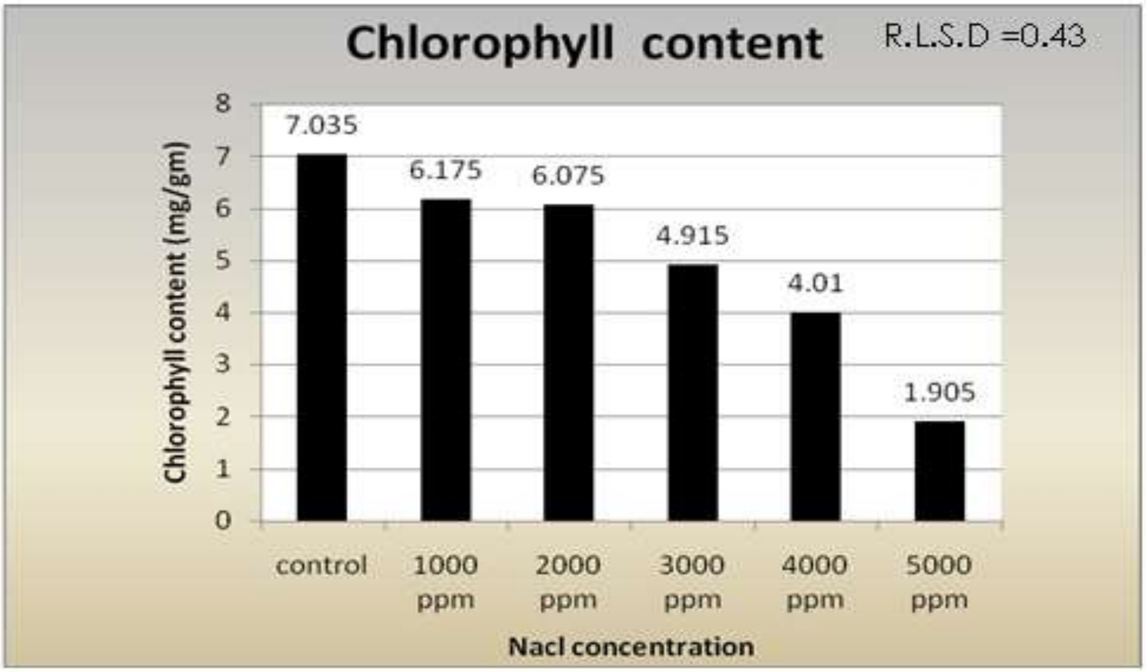

Figure 1.Chlorophyll content (mg/gm) of tomato seedling grown under NaCl concentrations

3- Plant Growth

Figure (2) shows that the stem height decreased with increasing salinity. The reduction of plant height was clear in plants under saline conditions. The leaf area was influenced by salinity, Figure (3) indicates that the leaf area grow less when the NaCl concentration decreased . The vegetative seedlings fresh and dry weights was affected by salinity.Figure (4,5) shows that the vegetative seedlings fresh and dry weights was obviously decreased with salinity. Figure 6,7 indicate that The fresh & dry root weight also decreased with increasing salinity. NaCl treatments was associated with differential effects on growth, metabolite concentrations and enzyme activities in the leaves and roots of tomato. However, many authors suggest that growth reduction by NaCl under a short time scale is caused by external osmotic changes (Munns and Termaat, 1986; Munns, 1993). The results indicated that the vegetative and root dry weights are decreased in saline condition, due to the exposure to NaCl stress. Similar outcome were obtained earlier by Mohammad *et al.*, (1998) in anther tomato cultivars. Saline stress leads to changes in growth, morphology and physiology of the roots that will in turn change water and ion uptake. The whole plants are then affected when roots are growing in saline medium. Finally, the results pointed out that NaCl stress have an impact upon plant growth, which results in a considerable decrease in leaf area and fresh and dry weights of vegetative and roots. Increasing salinity is accompanied also by significant reductions in plant height.

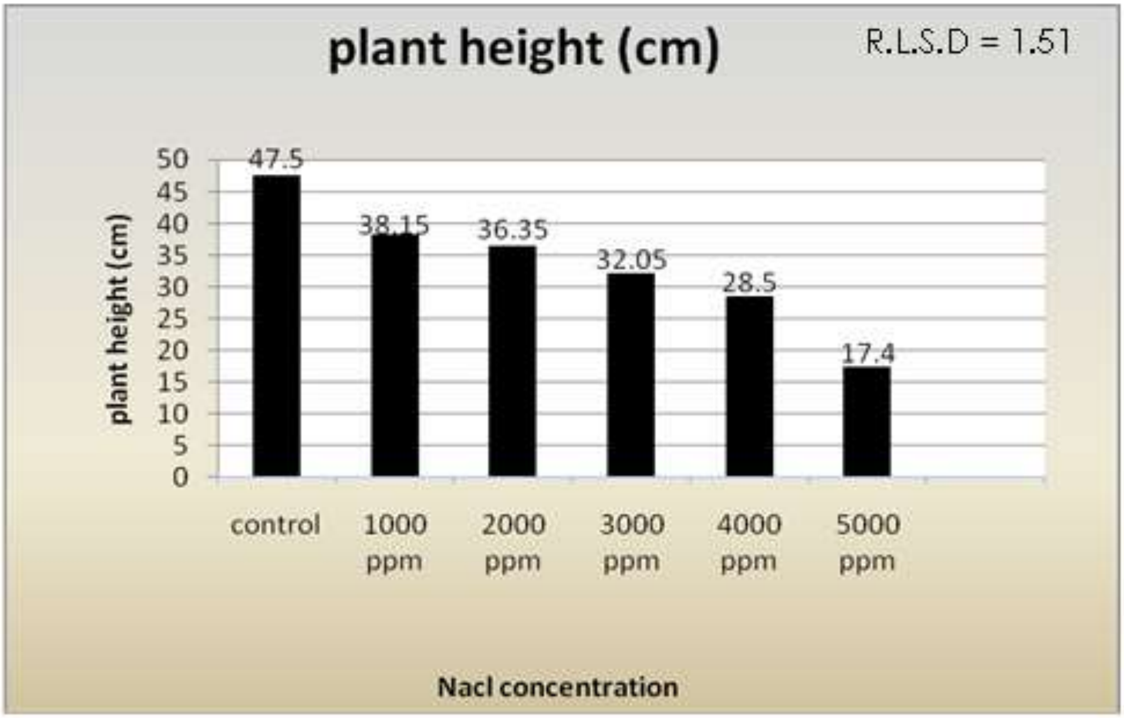

Figure 2.Plant height of tomato seedling grown under NaCl concentrations

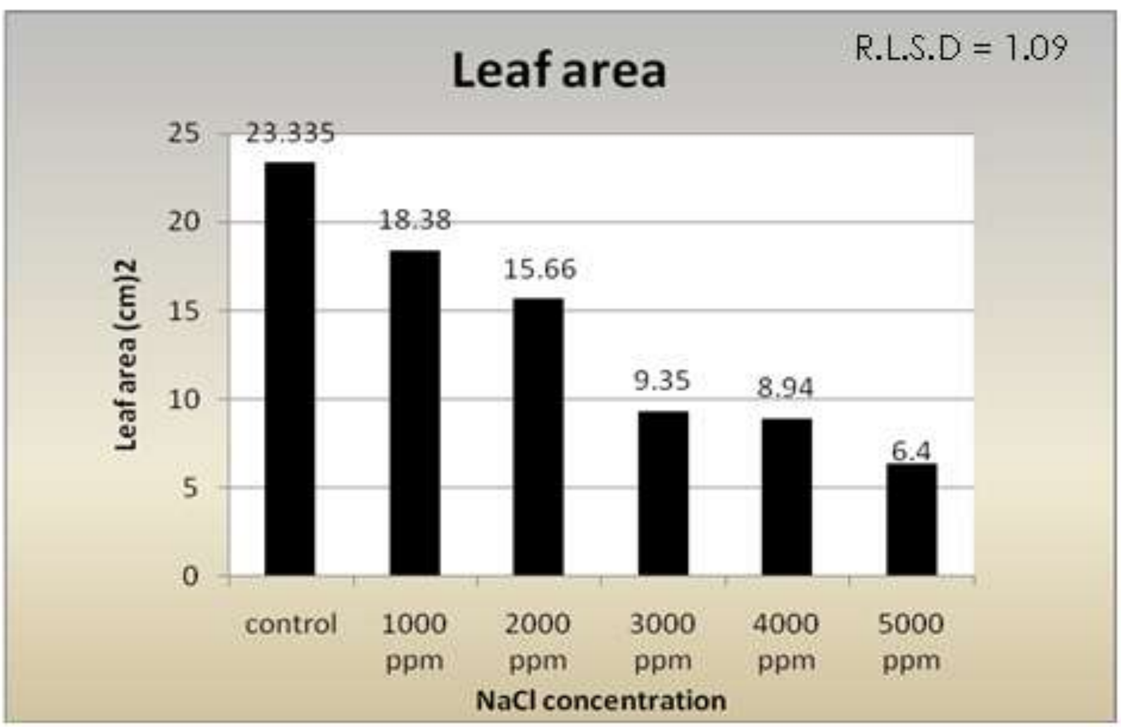

Figure 3. Leaf area$(cm)^2$ of tomato seedling grown under NaCl concentrations

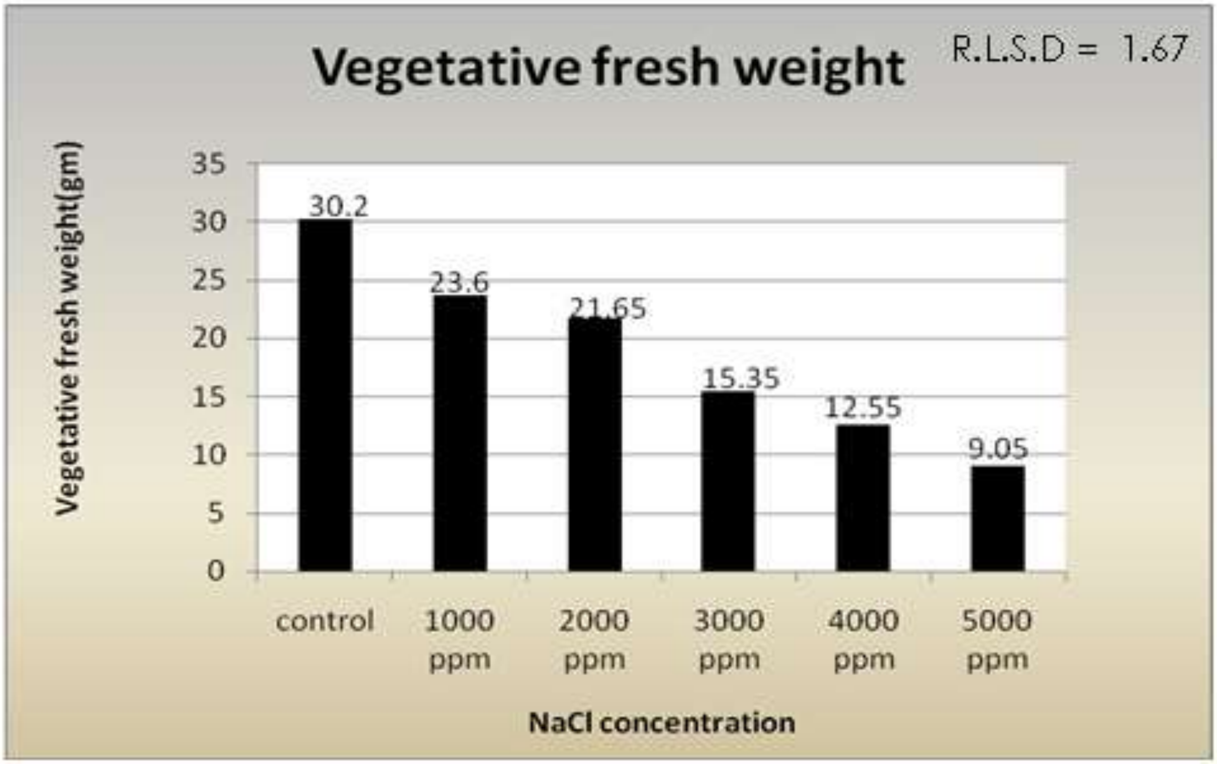

Figure 4.Vegetative fresh weight(gm) of tomato seedling grown under NaCl

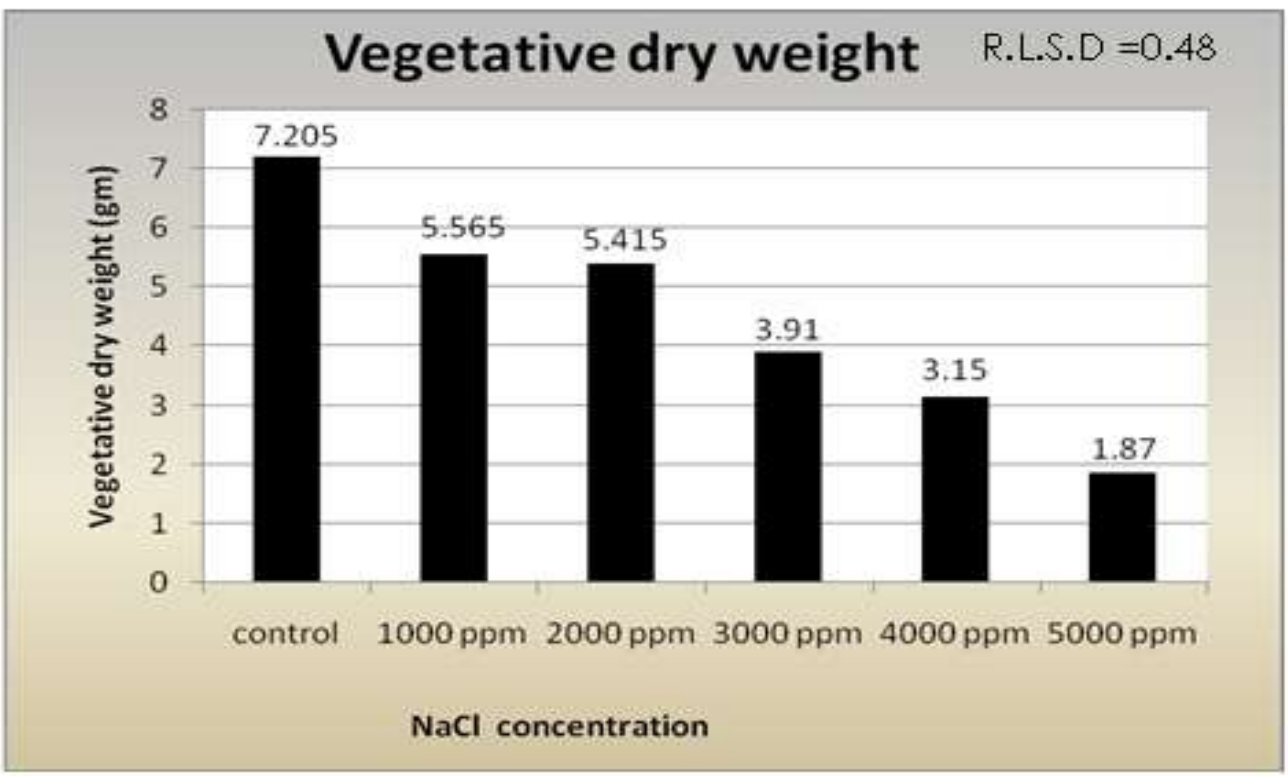

Figure 5. Vegetative dry weight (gm) of tomato seedling grown under NaCl concentrations

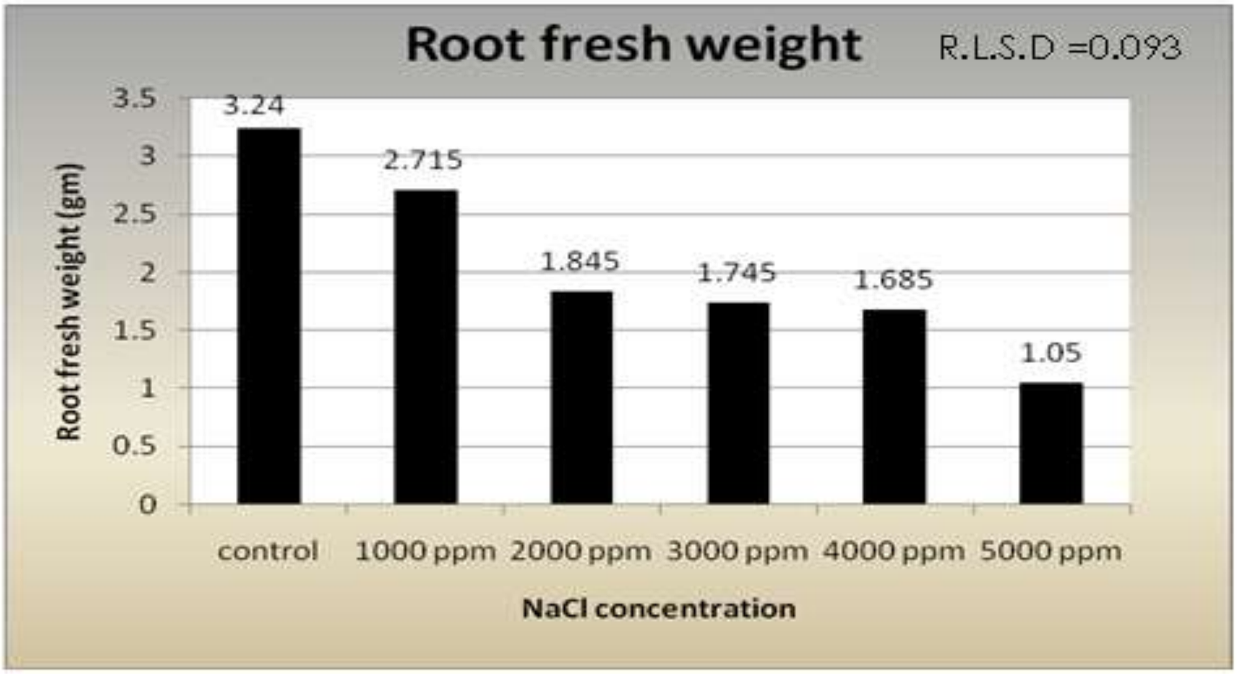

Figure 6. Root fresh weight(gm) of tomato seedling grown under NaCl concentrations

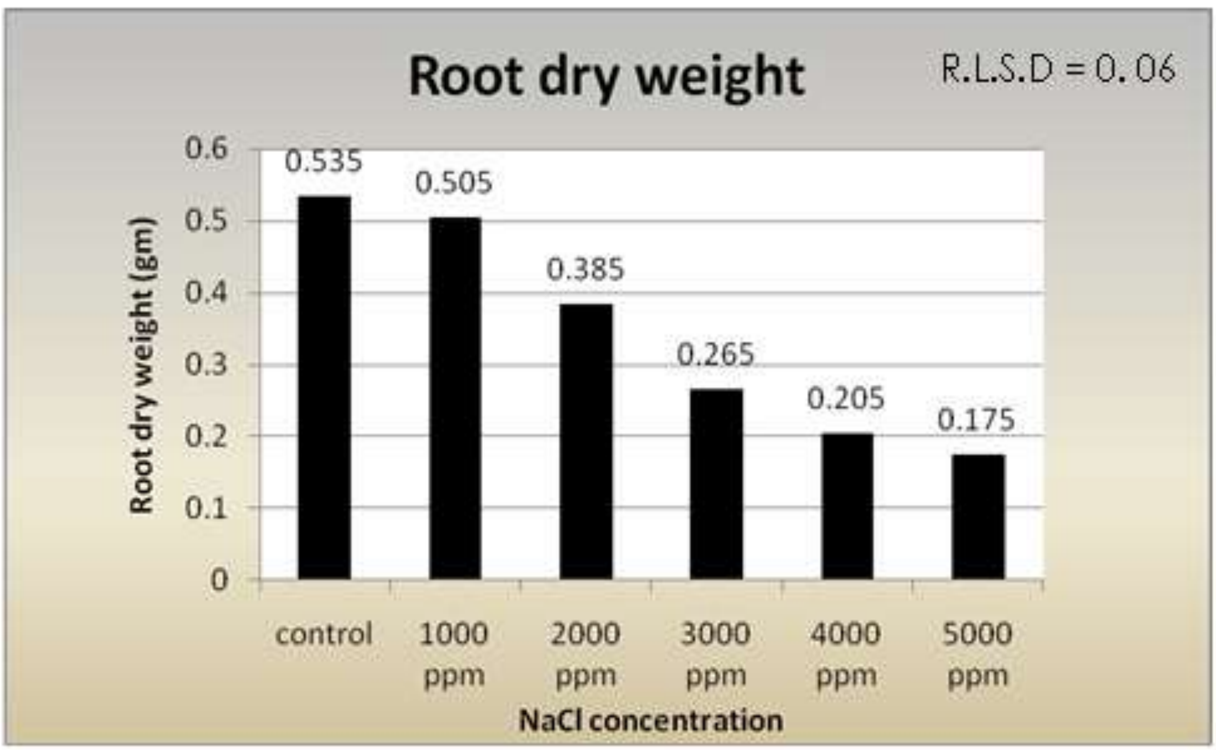

Figure 7. Root dry weight(gm) of tomato seedling grown under NaCl concentrations

4 – Mineral content

Figures (8,9,10,11) clearly indicate that the plants grown in soil to which saline water was applied, Salts treatments decreased the content of N, p and K, the total N uptake at lower level of salinity was significantly higher compared with the N uptake at the higher salinity level. The salt stress resulted in a decrease of N concentrations . The decrease in N concentrations by NaCl treatment may result from a disruption of root membrane integrity (Carvajal *et al.*, 1999), an inhibition N uptake (Bourgeais-Chaillou *et al.*, 1992; Parida and Das, 2004) and low N loading into root xylem (Abd-El Baki *et al.*, 2000). As Cl^{-} ions inhibit N uptake, the decrease in N concentrations can be attributed to competition between Cl^{-} and N for uptake by N transporters (Deane-Drummond, 1986), and/or an inactivation of N transporters by toxic effects of salt ions (Lin *et al.*, 1997). Accordingly, the greater N concentration decline in the leaves. Since, for The decrease in total N uptake by increasing salinity, apart from the effects of salinity on root growth, has been partly attributed to a probable substitution of Cl^{-} for $NO3^{-}$ (Feigin *et al.*, 1987; Martinez and Cerda, 1989). Under salt stress, nitrate uptake is slowed down and salinity reduces nitrate assimilation with the possible consequence of N deficiency in the plant.

The decreasing of Phosphorous concentrations in leaf were found to be associated with Cl- .Its possibly because of competition between Cl- and P uptake and consequently reduction of P availability to plants. Sharpley, *et al.*, (1992) suggested that phosphate availability is reduced in saline soils not only because of ionic strength effects that reduce the activity of phosphate but also because phosphate concentrations in soil solution are tightly controlled by sorption processes and by the low-solubility of Ca±P minerals.

Potassium concentrations were decreased significantly by increasing salinity levels and this was compensated by the accumulation of sodium. A slight reduction in K content in tomato plants. Reduction in K uptake in plants by Na is a competitive process and sodium induced K deficiency has been implicated in growth and yield reductions of various crops, including tomato (Lopez and Satti, 1996).
Data revealed that Na+ content generally increased with increase in salt concentration. Salinity raises Na concentration in the leaves, An increase in Na+ uptake and accumulation is often accompanied by a decrease in leaf K concentration , Many attributed this reduction to Na+ antagonism of K uptake . (Lopez and Satti, 1996).

Conclusions & Recommendation

The results indicate that application of Salinity that increasing NaCl stress caused a delay in the germination of seeds and reduction in shoot , root and whole plant growth ,the salinity increased the Na concentration and decreased the K , N of the tomato seedling leaves. With decreasing of salinity level in irrigated water , farmers should be getting and use the species which adapt under saline condition and tested from the agricultural researches center .

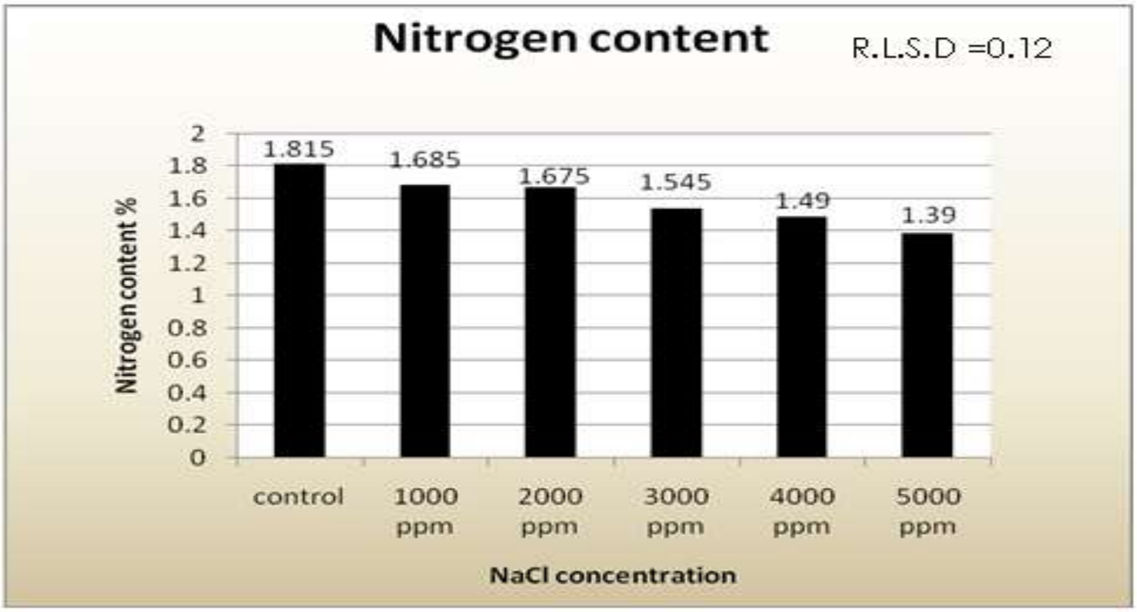

Figure 8. Nitrogen content in the leaves of tomato

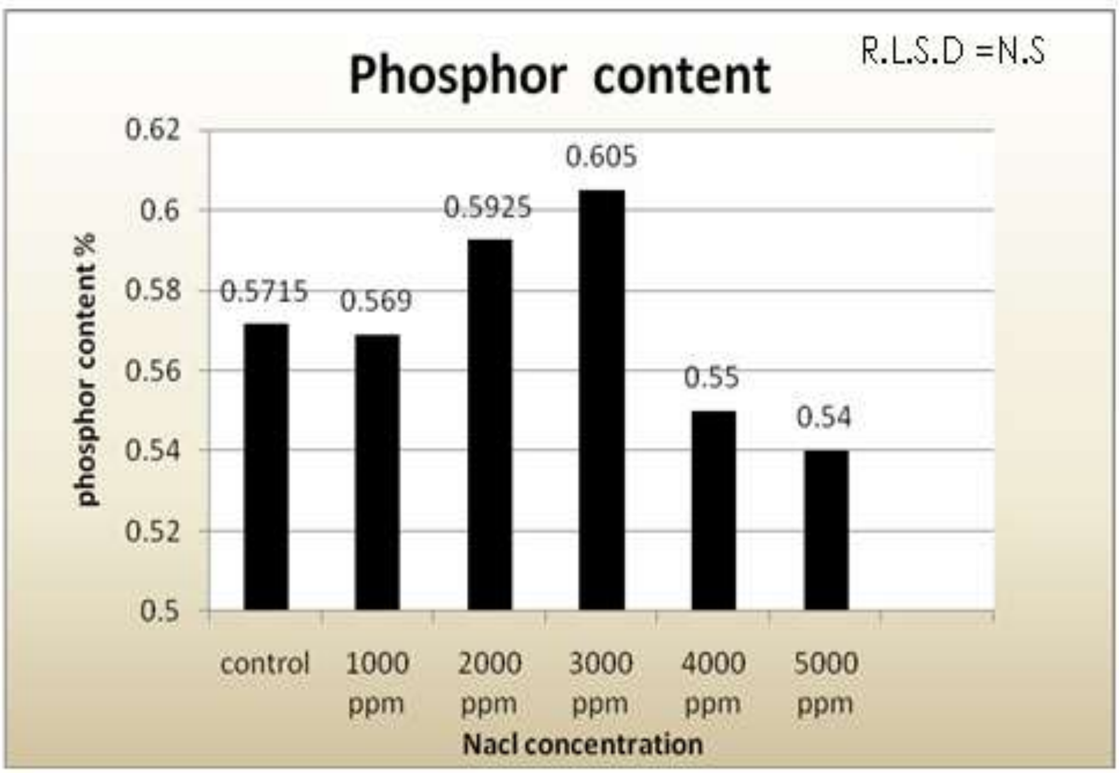

Figure 9. Phosphor content in the leaves of tomato

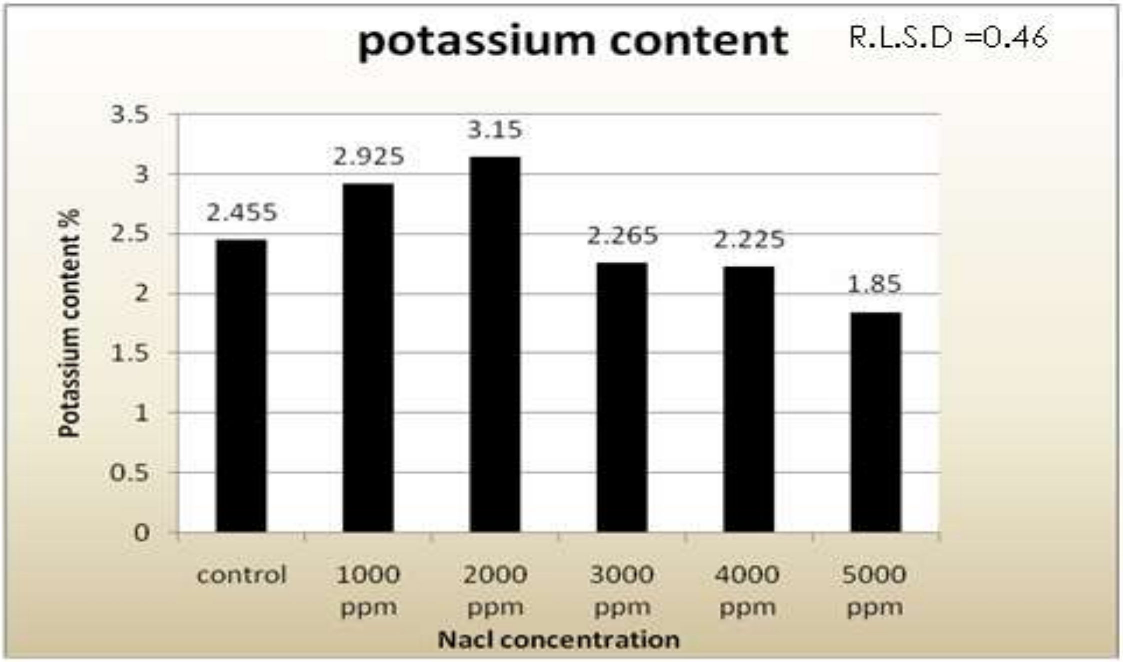

Figure 10. Potassium content in the leaves of tomato

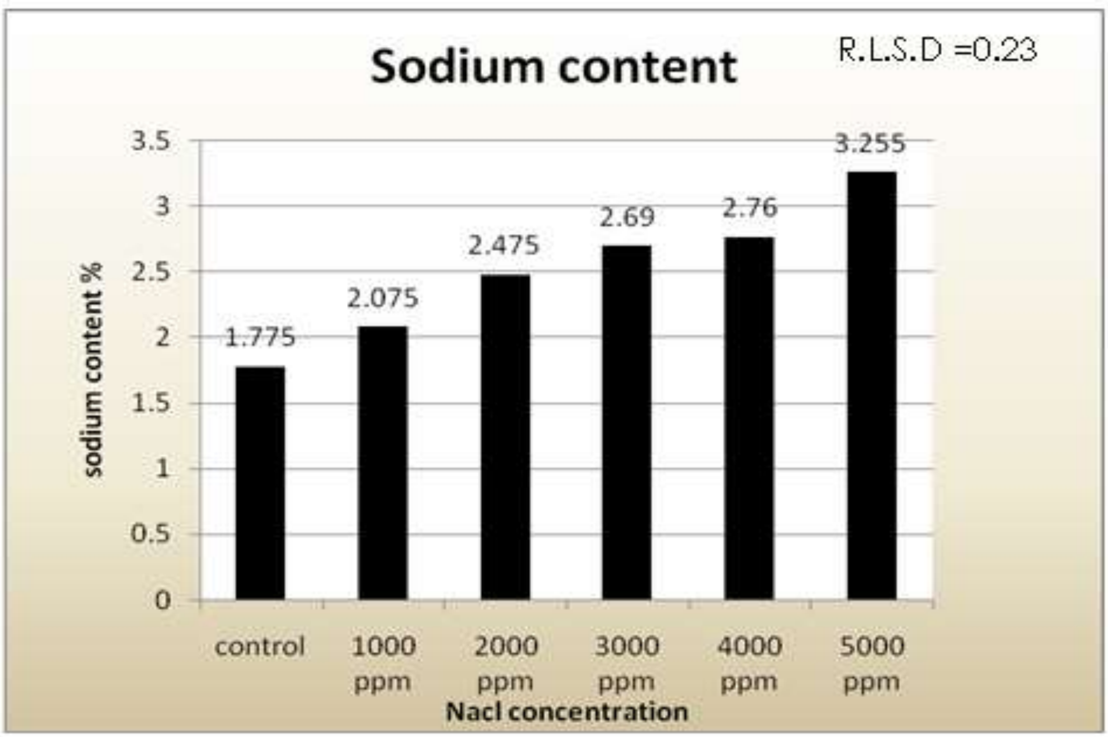

Figure 11. Sodium content in the leaves of tomato

Plate 1.The seed germination of tomato

Plate 2. Effect of NaCl treatments on Tomato seedlings

REFERENCES

*Abbas,M.F,Abbas,M.C(1992).Keeping and Storage of Fruit and Vegetables (practical).Dar Al-Hikma press.Basra University .pp:142.

*Abd-ElBaki G.K, Siefritz F., Man H.M., Weiner H., Haldenhoff R.and Kaiser W.M. (2000).Nitrate reductase in *Zea mays* L. under salinity. Plant, Cell and Environment 23:515–521.

*Adler, PR.,Wilcor, G.E. (1987). Salt stress, mechanical stress, or Chloromequat chloride effects on morphology and growth recovery of hydroponic tomato transplants. J. Amer. Hort. Sci., 112: 22-25.

Al-Karaki GN. (2000). Growth, water use efficiency, and sodium and potassium acquisition by tomato cultivars grown under salt stress. J. Plant Nutr. 23: 1-8.

*Al-Rawi,K.M.,Khalaf-Allah,A.M.(2000).Design and Analysis of Agricultural Experiments. University of Mosul.pp:488.

*Al-Rwahy S.A.(1989). Nitrogen uptake, growth rate and yield of tomatoes under saline condition. Ph.D. Dissertation, University of Arizona, Tucson.p. 118.

*Al-Sobhi, O.A., Al-Zahrani H.S., Al-Ahmadi S.B.(2005). Effect of salinity on chlorophyll &carbohydrate contents of *Calotropis procera* seedlings.King Fasil University J. and wild tomato species. J. Am. Hort. Sci., 112: 516-523.

*Apse MP, Blumwald E.(2002).Engineering salt tolerance in plants. Current Opinion in Biotechnology 13:146–150.

*Ashraf M, Bashir A. (2003).Salt stress induced changes in some organic metabolites and ionic relations in nodules and other plant parts of two crop legumes differing in salt tolerance. Flora 198:486–498.

*Ashraf M.Y., Bhatti A.S. (2000). Effect of salinity on growth and chlorophyll content in rice. Pak. J. Ind. Res. 43: 130-131.

*Ayers R.S. and Westcot D.W. (1985). Water quality for Agriculture. Irrigation and Drainage Paper 29, FAO, Rom. p. 174.

*Begum F., Karmoker J., Fattach Q. and Maniruzzaman A. (1992). The effects of salinity on germination seeds of *Triticum aestivum* L. cv. Akbar. Plant Cell Physiol, 33: 1009-1014.

*Bourgeais-Chaillou P., Perez-Alfocea F.,and Guerrier G. (1992).Comparatives effects of N-sources on growth and physiological responses of soybean exposed to NaCl-stress. Journal of Experimental Botany .43:1225–1233.

*Bremner, J.M. and C.S. Mulvaney, (1982). Nitrogen-total. pp: 595-624 In A.L. Page *et al.* (ed.) Methods of soil analysis. Part 2. 2nd ed. Agron. Monograph 9. ASA and SSSA, Madison, WI.

*Byari SH and Al-Maghrabi AA.(1991). Effect of salt concentration on morphological and physiological traits of tomato cultivar. Al-Azhar J.Agric. Res., 14: 19-11.

*Carvajal M., Martnez V. and Alcaraz F.C. (1999).Physiological function of water channels as affected by salinity in roots of paprika pepper. Physiologia Plantarum 105:95–101.

*Christiansen, MN. (1982). World environmental limitation to food and fiber culture. In: Breeding plants for less favorable environment, MN Christiansen and CF Lewis Edition, Wiley, New York. pp. 1-11.

*Cornillon P, Palloix A. (1997). Influence of sodium chloride on the growth and mineral nutrition of pepper cultivars. Journal of Plant Nutrition 20:1085–1094.

*Cramer, G.R., G.J. Alberico and C. Schmidt, (1994). Leaf expansion limits dry matter accumulation of saltstressed maise.Australian Journal of Plant Physiology 21,663-674.

*Croser C., Renault S., Franklin J.and Zwiazk J. (2001). The effect of salinity on the emergence and seedling growth of *Picea mariana*, *Picea glauca* and *Pinus banksiana*. Environ Pollut, 115: 9-16.

*Deane-Drummond C.E. A.(1986) comparison of regulatory effects of chloride on nitrate uptake, and of nitrate on chloride uptake into *Pisum sativum* seedlings. Physiologia Plantarum 66:115–126.

*Del Amor, F.M., V. Martinez and A. Cerda,(2001). Salt tolerance of tomato plants as affected by stage of plant development., 36(7): 1260-1263.

*Essa A.T., Al-Ani D.H.(2001). Effect of salt stress on the performance of six soybean genotypes. Pak. J. Biol. Sci. 4: 175-177.

*Feigin, A., I. Rylski, A. Meiri and J. Shalhevet, (1987). Response of melon and tomato plants to chloridenitrate ratios in saline nutrient solutions. J. Plant Nutr., 10: 1787-1794.

*Flores P, Botella M.A., Martínez V. and, Cerdá A. (2000). Ionic and osmotic effects of nitrate reductase activity in tomato seedlings. Journal of Plant Physiology 156:552–557.

*Flowers TJ, Troke PF, Yeo AR (1977). The mechanism of salt tolerance in halophytes. Annu. Rev. Plant Physiol, 28: 89-121.

*Gornat B, Goldberg D, Rimon D, Ben-Asher J. (1973). The physiological effect of water quality and method of application on tomato,cucumber and pepper. J. Am. Hort. Sci., 98: 202-205.

*Halperin ST, Gilroy S. and Lynch J.P. (2003) . Sodium chloride reduces growth and cytosolic calcium, but does not affect cytosolic pH, in root hairs of *Arabidopsis thaliana* L. Journal of Experimental Botany 54:1269–1280.

*Hasegawa P.M, Bressan R.A, Zhu J.K. and Bohnert HJ. (2000). Plant cellular and molecular responses to high salinity. Annual Review of Plant Physiology and Plant Molecular Biology 51:463–499.

*Jackson,M.L.(1958).Soil chemical analysis .1st .ed.prentice-Hallinc,Englewood, Cliffs New Jersey.

*Khavarinejad R.A.and Mostofi Y.(1998). Effects of NaCl on photosynthetic pigments, saccharides, and chloroplast ultra structure in leaves of tomato cultivars, Photosynthetica 35: 151–154.

*Lin H, Sandra S.S, and Schumaker K.S.(1997). Salt sensitivity and the activities of the H-ATPase in cotton seedlings. Crop Science .37:190–197

*Lopez, M.V. and S.M.E. Satti, (1996). Calcium and potassium-enhanced growth and yield of tomato under sodium chloride stress. Plant Sci., 114: 19-27.

*Maas, E.V., (1986). Salt tolerance of plants. Applied Agricultural Research, 1: 12-26.

*Maas, E.V., (1993). Plant growth response to salt stress. pp: 279–291. In H. Lieth and A. Al Masoom (ed.) maize. Aust. J. Plant Physiol., 21: 663-674.

*Martinez, V. and A. Cerda, (1989). Influence of N source on rate of Cl, N, Na, and K uptake by cucumber seedlings grown in saline conditions. J. Plant Nutr., 12: 971-983.

*Mohammad M., Shibli R., Ajouni M. and Nimri L. (1998). Tomato root and shoot responses to salt stress under different levels of phosphorus nutrition. J. Plant Nutr. 21: 1667-1680.

*Munns R., Termaat A. (1986). Whole plant responses to salinity. Australian Journal of Plant Physiology 3:143–160.

*Munns R. (1993). Physiological process limiting plant growth in saline soil: some dogmas and hypothesis. Plant, Cell and Environment 16:15–24.

*Omar M.A., Omar F.A.and Samarrai SM. (1982). Effect of different soil treatments on tomato plants grown in Wadi Fatima soil. B. Effect salinity treatments. Technical Report, Faculty of Meteorol-Environ and Arid Land Agric.p. 26.

*Parida A.K. and Das A.B. (2004). Effects of NaCl stress on nitrogen and phosphorus metabolism in a true mangrove *Bruguiera parviflora* grown under hydroponic culture. Journal of Plant Physiology 161:921–928

*Satti S.M. and Al-Yahyai R.A. (1995). Salinity tolerance in tomato: Implications of potassium, calcium and phosphorus. Soil Sci. Plant Anal. 26: 2749-2760.

Shannon M.C, Gronwald J.W. and T.A.L. M (1987). Effect of salinity on growth and accumulation of organic and inorganic ions in cultivated and wild tomato species. J. Am. Hort. Sci., 112: 516-523.

*Sharpley, A.N., J.J. Meisinger, J.F. Power and D.L. Suarez, (1992). Root extraction of nutrients associated with long-term soil management. In: Stewart, B. (Ed.), Advances in Soil Science, 19: 151-217.

*Szabolcs I. (1994). Prospects of soil salinity for the 21st century. July; I. 15th World Congress of Soil Science. Acapulco, 10–16. 123–141. 1994

تأثير الملوحة على إنبات بذور ونمو بادرات الطماطة

(*Lycopersicon esculentum*)

كريمة فاضل عباس

قسم علوم الحياة - كلية العلوم- جامعة البصرة

الخلاصة

أجريت الدراسة الحالية في احد البساتين الخاصة منطقة أبي الخصيب خلال موسم النمو ٢٠٠٩ لمعرفة مدى تأثير الملوحة في مياه الري على نمو نبات الطماطة، وقد استخدمت ستة تراكيز (٠ و ١٠٠٠ و ٢٠٠٠ و ٣٠٠٠ و ٤٠٠٠ و ٥٠٠٠ ppm لملح كلوريد الصوديوم NaCl). تضمنت التجربة على مرحلتين، إنبات البذور ونمو النباتات. وبينت النتائج إن زيادة الملوحة في مياه الري تؤدي إلى التأخير في إنبات البذور وكذلك إلى قلة عدد البذور النابتة، وعند التراكيز العالية من NaCl (5000 ppm) لوحظ عدم حصول أي إنبات للبذور. أما محتوى الكلوروفيل ومتوسط مساحة الورقة فقد انخفض مع زيادة الملوحة و قد انخفض ارتفاع النبات مع زيادة الملوحة كما في الوزن الطري والجاف للمجموع الخضري والجذري .إن زيادة مستوى الملوحة في مياه الري قد خفض محتوى الأوراق من عنصري N,K ولم يخفض محتواها من عنصر P ، وعمل على زيادة محتواها من عنصر Na.