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 tolerate 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-Rawahy, 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 February 15th 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 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 ground 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 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.
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).

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

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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 another 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 (cm²) of tomato seedling grown under NaCl concentrations.
Figure 4. Vegetative fresh weight (gm) of tomato seedling grown under NaCl concentration.

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-. It’s 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 get 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


تأثر الملوحة على إنبات بذور ونمو بادرات الطماطة

(Lycopersicon esculentum)

كريمة فاضل عباس
قسم علوم الحياة - كلية العلوم - جامعة البصرة

الخلاصة

أجريت الدراسة الحالية في أحد البساتين الخاصة منطقة أبي الخصيب خلال موسم النمو 2009 لمعرفة مدى تأثير الملوحة في مياه الري على نمو نباتات الطماطة، وقد استخدمت ستة تركيزات (0 و 1000 و 2000 و 3000 و 4000 و 5000 ppm) لملح كلوريد الصوديوم (NaCl). تضمنت التجربة على مرتين، إنبات البذور ونمو النباتات. وبينت النتائج أن زيادة الملوحة في مياه الري تؤدي إلى التأخير في إنبات البذور وكذلك إلى قلة عدد البذور الناتجة، عند التركيز العالية من NaCl (5000 ppm) لملاحظة بطء حصول أي إنبات للبذور. أما محتوى الكلوروفيل ومتوسط المساحة النباتية فقد انخفض مع زيادة الملوحة وقد انخفض ارتفاع النباتات مع زيادة الملوحة كما في الوزن الطري والجاف للمجموع الخضري والجذري. إن زيادة مستوى الملوحة في مياه الري قد خفض محتوى الأوراق من عنصر P، وعمل على زيادة محتواها من عنصر N،K وعمل على زيادة محتواها من عنصر Na.