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Study of the Effects Irrigation Water Salinity and pH on Production and Relative Absorption of some Elements Nutrient by the Tomato Plant

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Abstract: Problem statement: This study was conducted to examine the effects of irrigation water pH and Salinity on the growth and absorption of P, Na, Ca, K by tomato. **Approach:**The study includes two Salinity and pH factors and is consisted from 12 treatment and three repetitions. Tomato seeding grown in foam trays were transplanted in the joune 2010 to bags filled with perte in an Greenhouse at Damghan Islamic Azad University of Iran. Plant were divided into groups then irrigated with the targeted sane and pH levels. Plants were hand-irrigated with fresh water and fertized with required nutritional solutions were prepared based on bed nutrients mitation. Greenhouse temperature was maintained in suitable level using air conditioner and its humidity was controlled by hygrometer and adjusted in the range of 60-80%. Water Salinity factors were consisted from four levels (0, 3, 6 and 9 dsm^{-1}) and pH factor was consisted from three levels (6.5, 7.5 and 8.5). Salinity and pH treatments were adjusted with Nacl and H_2SO_4/N_2CO_3 salts respectively. Study of the effects of Salinity and pH level on tomato were recorded and controlled depending on number of growing fruit, fertized flowers, plant dry weight, plant height, percentage of P, Na, Ca, K in leaves. Then results were studied by Anova Variance Analysis using SAS software and obtaining significant results, Dunken test was used for comparison of average levels in probabity level of 5%. **Results:** Data showed that all growth parameters such as plant height, leaf area, plant dry weight, percentage of P,Ca,K in leave responded negatively as the Salinity and pH level increased. Only Na^+ content in the leaves responded positively to increment in Salinity and pH level. **Conclusion:** Based on results, Salinity reduced plant height as well as dry weight and increasing of Salinity and pH increased supply of Na+ in tomato leaf.

Key words: Irrigation water , required nutritional solutions, ANOVAs variance, growth parameters, salts respectively, nutrients mutation, responded negatively, plant dry weight

INTRODUCTION

Salinity is an environmental stresses that mits growth and development in plants. The response of plants to excess NaCl is complex and involves changes in their morphology, physiology and metabosm (Hilal *et al*., 1998). Translocation of salt into roots and to shoots is a outcome of the transpirational flux required to maintain the water status of the plant and unregulated transpiration may cause toxic levels of ion accumulation in the shoot (Yeo *et al*., 1997; Takase *et al*., 2011). The supply of mineral ions to the leaf growing region may decne. The responses of plants to high Salinity may be expected to vary with different growth stages. This has been shown in pepper; Chartzoulakis and Loupassaki (1997) in eggplant; Dumbroff and Copper (1974) in tomato and Oad *et al*. (2001) in Corn. Young seedngs and plants at the flowering stage seem to be more sensitive than mature stages (Lutts *et al*., 1995). Salt tolerance of plants can be grouped in three categories: (Achilea *et al*., 2002) exclusion of salt followed by transport and compartmentation of salt, (Adams, 1988) morphological features and biomass distribution of

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plant shoots and roots and (Adams, 1991) physiological and metaboc events that counteract the presence of salt at cellular level (Winicov, 1998). Other workers have nked NaCl stress with macro-nutrient deficiencies, for example high NaCl concentration has been shown to induce phosphorus and potassium deficiencies in tomato (Adams, 1988, 1991; Takase *et al*., 2010) and in cucumber (Sonneveld and de Kreij, 1999). The experiment was conducted to investigate the effects of Salinity and pH on growth parameters and also to study the effects of supplementary P and K^+, Ca^{2+}, Na^+ on salt stressed during growth period.

MATERIALS AND METHODS

Tomato seedngs grown in foam trays were transplanted in the joune 2010 to bags filled with perte in an Greenhouse at Damghan Islamic Azad University of Iran.

Greenhouse temperature was maintained in a suitable level using air conditioner and moisture was adjusted in the range of 60-80% with hygrometer.Plants were hand-irrigated with fresh water and fertized with required nutritional solutions were prepared based on bed nutrients mitation and considering the need concentration of nutrients for tomato in Greenhouse (critical level). The study includes two Salinity and pH factors consisted from 12 treatments and three repetitions. Four levels of Salinity namely T1 = 0, T2 = 3, T3=6,T4=9 ds m^{-1} were estabshed by dissolving Nacl salt in fresh water until reaching the concentrations. PH factor was consisted from three level (t1 = 6.5, t2 = 7.5 and t3 = 8.5). pH cultures were adjusted with H_2SO_4/N_2CO_3 salts respectively. Plant were divided into groups then irrigated with the targeted sane and pH levels. Irrigation was carried out daily and each irrigation cycle ,enough drain was allowed to adequate leaching and until reaching the targeted level of Salinity in the drain. Test plan was executed in the form of factorial and in the framework of totally random basic plan. The plants were supped with the standard nutrient solution during the growing season.

To determine the influence of pH and Salinity on the uptake of P, Na^+, Ca^{2+}, K^+ and vegetative and productivity characters ,young fully expanded leaves and fruits were sampled from each experimental unit in end of research.The above samples were dried at 65°C to constant weight and used to determine the P, Na^+, Ca^{2+}, K^+ concentration.Recorded data included on number of growing fruit, fertized flowers, dry matter (%), plant height(cm), percentage of leave phosphor(%) and leave area scale(cm^2)from the fourth leaf from the top and was determined using leaf area meter machine. Then results were studied by ANOVA Variance Analysis using SAS software and obtaining significant results, Dunken test was used for comparison of average levels in probabity level of 5%.

RESULTS

Porte properties: Results from analysis of physicochemical specifications of the perte as plant bed is given in Table 1.

Nutritional solutions: Table 2 shows Composition of the used nutritional solutions for tomato during the growing season.

Vegetative and productivity characters of tomato: Table 3 indicates effects of different Salinity and pH levels on vegetative and productivity characters of tomato. Results showed that with increasing the level of Salinity and pH singnificantly reduced vegetative and productivity characters of tomato.Vegetative growth in terms of number of growing fruit, fertized flowers,plant dry matter, plant height responeded negatively to increasing the level of pH and Salinity under the studied range.The most plant height in different teratment was obtained in control treatment(t1=6.5,T1=0 dsm^{-1}).Shortest height was seen in the irrigated treatment using of 9 ds m^{-1} Salinity and pH of 8.5 (t3= 8.5 and T4=9).Most number of fertile flowers in different treatments was obtained in control culture.Results indicated that fertile flowers responded negatively to the increment in Salinity and pH level as shown in Table 3. Most fertile flowers are obtained in zero Salinity(T1)and pH of 6.5 (t1) and the least flowers are seen in Salinity of 9ds m^{1-}(T4) and pH=8.5(t3).Highest plant dry weight in different treatments was obtained in treatment T1 and t1. With increasing Salinity and pH in irrigation water, plant dry weight is decreased. Highest index of leave area in different treatments was obtained in treatment T1,t1 and the lowest was related to T4,t3.

Results showed that most ripen fruits in different treatment was obtained in T1,t1. Most number of ripen fruits were obtained in zero Salinity and pH of 6.5 while the least obtained in treatments of T4, t3.

Concentration of leaf P, K^+, Na^+, Ca^{2+}: Table 3 indicate P,K^+,Na^+,Ca^{2+} percentage in tomato leaf. Results showed that the effects of Salinity and pH is significant on uptake of ions by tomato (Fig. 1-18).The increase of EC and ph from 0-9 ds m^{-1} and 6.5-8.5 respectively, had significant influence on the Uptake of leaf P, K^+, Na^+, Ca^{2+} by tomato. The increase of Salinity and pH decreased supply of P,K^+,Ca^{+2} and increased supply of Na^+ in tomato leaf. Highest leaf P, K^+ and Ca^{2+} percentage in different treatment was obtained in treatmentT1,t1.

Table 1: Physical properties of used perlite

Attribute		Attribute	
Color	White and Grey	PH	7.00
Densities	From 1100 kg m^{-3} (1.1 g cm^{-3}) to 30–150 kg m^{-3}(expanded perlite)	Composition	(70-75% silicon dioxide: SiO_2), (12-15% aluminum oxide: Al_2O_3), (3-4% sodium oxide: Na_2O),(3-5% potassium oxide: K_2O), (0.5-2% iron oxide: Fe_2O_3,0.2-0.7% magnesium oxide: MgO), (0.5-1.5% calcium oxide: CaO), (3-5% loss on ignition (chemical/combined water)
Porous texture	Surface pores or cavities develop on perlite particles during dilation These pores trap moisture on which plant roots thrive.	Liquid retention	Perlite's porous texture retains moisture and fertilizers. Perlite absorb water 1.14 times its weight.
Air circulation	Because of their irregular shape, perlite particles provide aeration in growing mixes	EC (Electrical Conductivity)	2.26 ds m^{-1}
Size	2-5 mm		

Table 2: Effects of different salinity and pH levels on plant vegetative and productivity characters

Characters	Plant dry weight (g)	Leaf area index	Fertilized flower	Flower number	plant height (cm)
Salinity					
T1	71.16	2.85	7.44	17.00	47.33
T2	50.37	2.50	4.55	11.33	33.44
T3	16.74	1.49	0.77	03.00	26.00
T4	06.96	0.33	0.00	00.00	09.50
pH					
t1	40.04	1.89	4.08	8.83	31.83
t2	36.20	1.81	3.25	8.00	28.83
t3	32.69	1.86	2.25	6.66	26.54

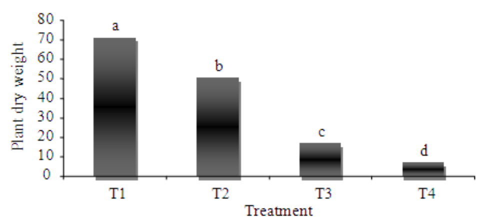

Fig. 1: Variation in plant dry weight in different treatments

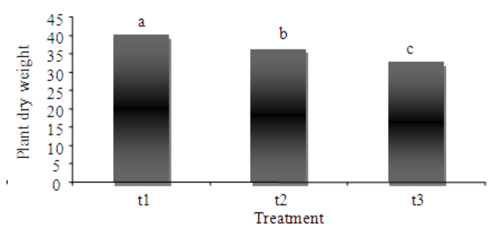

Fig. 2: Variation in plant dry weight in different treatments (ph)

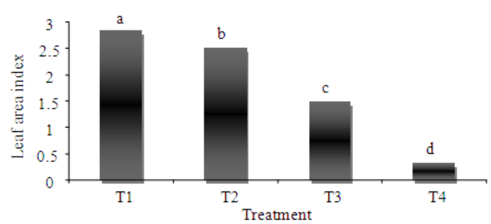

Fig. 3: Variation in leaf area index in different treatments (salinity)

Table 3: Effects of different salinity and pH levels on P, K^+, Na^+, Ca^{2+} concentration in tomato leaf

Treatment	Leaf ions (percent)			
Salinity	P	K^+	Na^+	Ca^{2+}
T1	0.56	4.10	0.52	1.70
T2	0.27	3.10	0.61	1.50
T3	0.14	2.51	0.72	1.31
T4	0.07	1.72	1.10	1.01
pH				
t1	0.30	3.90	0.51	3.41
t2	0.27	3.11	0.72	2.80
t3	0.21	2.71	0.96	2.13

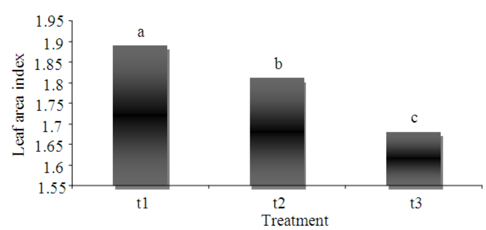

Fig. 4: Variation in leaf area index in different treatments (pH)

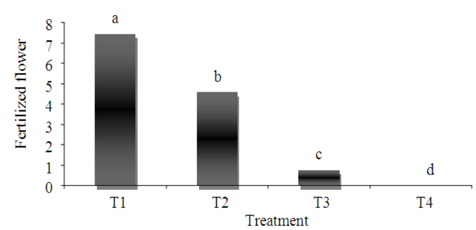

Fig. 5: Variation in fertilized flower in different treatments (salinity)

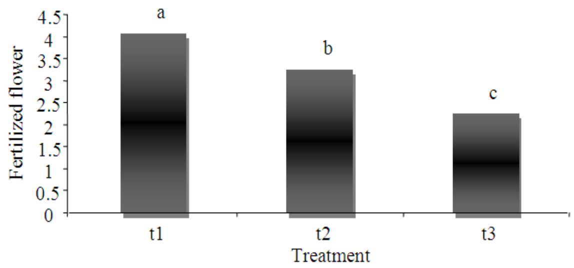

Fig. 6: Variation in fertilized flower in different treatments (pH)

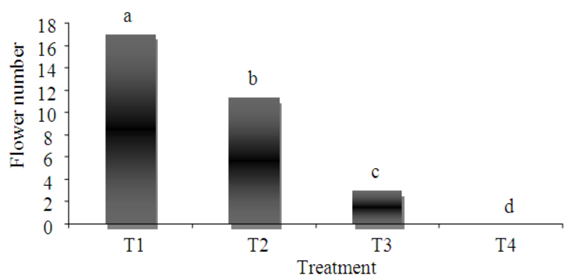

Fig. 7: Variation in flower number in different treatments (salinity)

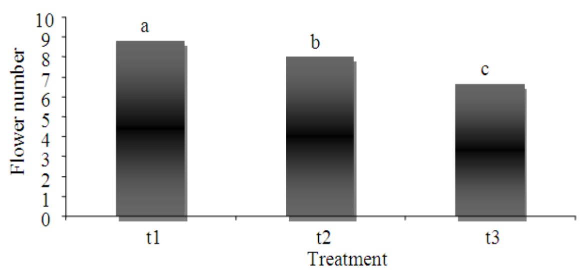

Fig. 8: Variation in flower number in different treatments (pH)

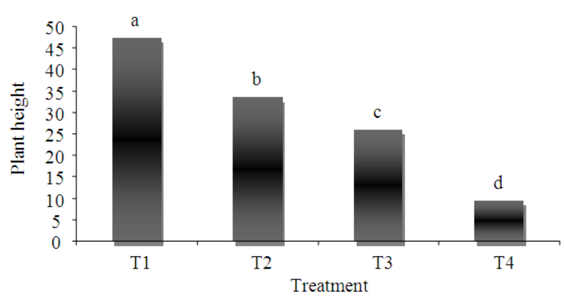

Fig. 9: Variation in plant height in different treatments (salinity)

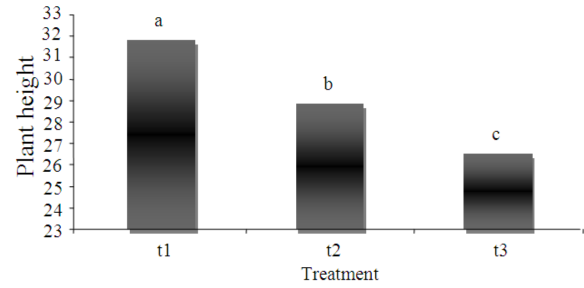

Fig. 10: Variation in plant height in different treatments (pH)

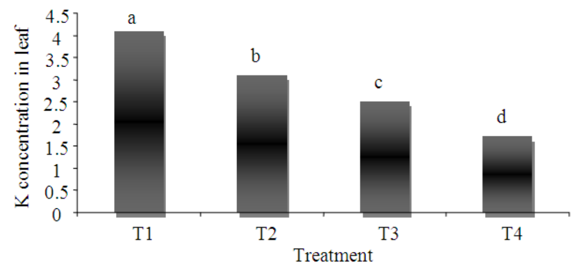

Fig. 11: Variation in K^+ concentration in different treatments (salinity)

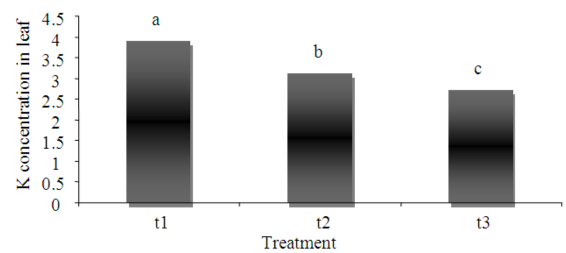

Fig. 12: Variation in K^+ concentration in different treatments (pH)

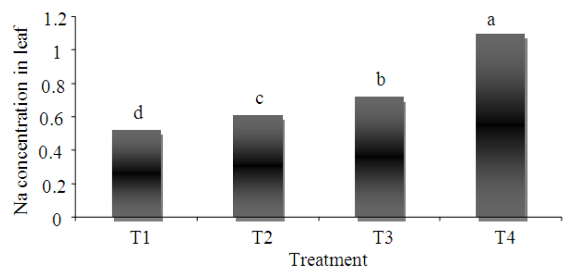

Fig. 13: Variation in Na^+ concentration in different treatments (salinity)

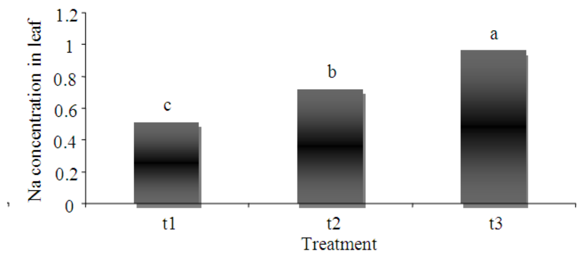

Fig. 14: Variation in Na^+ concentration in different treatments (pH)

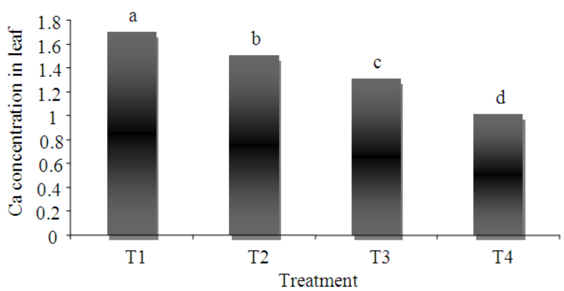

Fig. 15: Variation in Ca^{+2} concentration in different treatments (salinity)

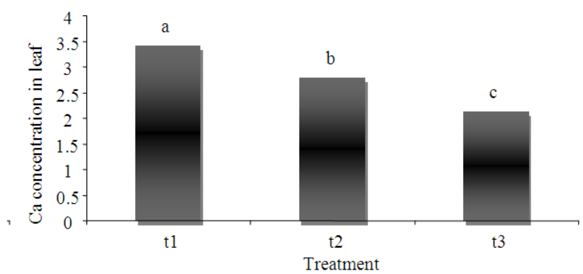

Fig. 16: Variation in Ca^{+2} concentration in different treatments

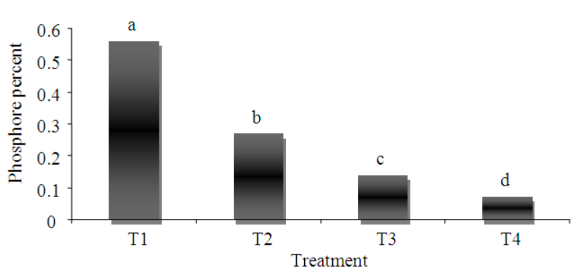

Fig. 17: Variation in P concentration in different treatments (salinity)

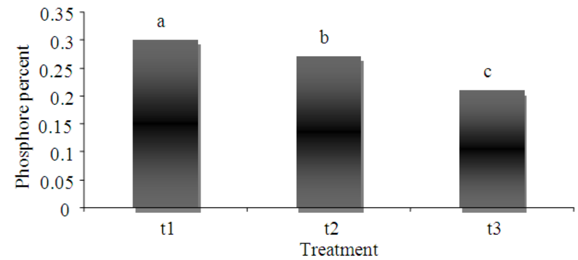

Fig. 18: Variation in P concentration in different treatments (pH)

DISCUSSION

As mentioned above, salinity is commonly reducing growth and production of many vegetable crops such as tomatoes (Hayward and Long, 1943; Sanchez and Azuara, 1979; Li, 2000; Tantawy, 2007; Ebrahimizadeh *et al*., 2009). In this study and in agreement with previous studies, Salinity reduced plant height (Achilea *et al*., 2002; Agong *et al*., 2004; Hajer *et al*., 2006) and leaf area (Li and Stanghelni, 2001; Mulholland *et al*., 2002; Maggio *et al*., 2004; Agong *et al*., 2004), fresh weight (Hassan *et al*., 1999; Sonneveld, 2000; Amico *et al*., 2003; Hajer *et al*., 2006) as well as dry weight (Li, 2000). Salinity affects plant growth by weakening the plant's abity to absorb water from the bed it ves in. The large amount of salt found in plant bed affected by Salinity makes it hard for the plant to absorb all the nutrients necessary to be healthy.

As a result, most of the plants become weaker: And in some cases, end up dying. Plants that are found in bed with high Salinity usually absorb high concentrations of ions such as Na and cl.

The presented results indicated that increasing of Salinity and pH restrict the uptake of K^+ ,Ca^{+2} and P ions. High Salinity reduced uptake of Ca^{2+}, k^+, P mainly in the leaves. Accumulation of salts, can cause plant growth problems and result in poor growth or death of plants. Also pH affects the plant growth because it affects the availabity of nutrients to the plants .The ratio in uptake of anions (negatively charged nutrients) and cations (positively charged nutrients) by plants may cause substantial shifts in pH.

Most varieties of vegetables grow at their best in a nutrient solution having a pHbetween 6.0 and 7.5 and a nutrient temperature between 20 and 22°C. The results showed increasing of Salinity and pH increased supply of Na^+ in tomato leaf.

This can be cuases high levels of bed Na will displace Ca,K and lead to Ca and K leaching. As soil Salinity increased, the K/Na and Ca/Na ratios in the soil and plant decreased.

CONCLUSION

According this study, Salinity can reduce hte plant height as well as dry weight and increasing of Salinity and pH increased supply of Na+ in tomato leaf and vegetables (optimal conditions are a nutrition with pH between 6.0 and 7.5 and a nutrient temperature between 20 and 22 ^{O}C). increase of Salinity and pH can cause increase of supply of Na+ in tomato leaf and vegetables.

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