Asian Journal of Chemistry Vol. 19, No. 4 (2007), 3093-3098

Effect of The Water Salinity Level on Yield and Fruit Quality of Pepper (*Capsicum annuum* L.)

TEKIN KARA*, EMINE EKMEKCI and MEHMET APAN
Department of Agricultural Structures and Irrigation Engineering
Faculty of Agriculture, Ondokuz Mayis University, 55139 Kurupelit, Samsun, Turkey
Fax: (90)(362)4576034; Tel: (90)(362)3121919 Ext: 1354
E-mail: tekinkar@omu.edu.tr

The effect of five irrigation water salinities (0.34, 1.00, 2.50, 4.00, 6.00 dS m^{-1}) and two Ca:Mg ratio levels (1:1 and 3:1) on yield and some quality parameters of a pepper (*Capsicum annuum* L.) were investigated under greenhouse conditions. A full randomized factorial experiment was conducted on April 18, 2005 at the Greenhouse Station, Ondokuz Mayis University. Yield, fruit quality data were collected. The saline irrigation water was obtained by adding NaCl, $CaCl_2$ and $MgSO_4$ to tap (control) water. According to treatment results the yield decreased with increasing salinity level with starting at salinity level of 1.00 dS m^{-1} and continued to 6.00 dS m^{-1}, $p < 0.05$. But there is no significant Ca : Mg ratios effect to yield. The loss in yield reaches 80 % with increasing salinity level. Increasing salinity level resulted in smaller fruit size, plant height and root depth. However, increasing salinity level resulted in increase oven-dry mineral material of the fruits, leaves and the stem.

Key Words: Salinity, Pepper, Yield, Fruit quality.

INTRODUCTION

The shortage of rain and capillarity rise from shallow ground water or from sea water intrusion in coastal areas makes necessary the use of water of low quality for irrigation[1]. The use of saline water for irrigation purposes with the risk of salt accumulation in the root zone and consequent damage to crop production and soil fertility[2].

Nearby half of the irrigated surface is seriously affected by salinity[3]. In Mediterranean areas salinity is an increasing problem[4]. In coastal areas, seawater intrusion into the groundwater due to excessive withdrawals causes increasing salinity of both water resources and soils[5]. It is difficult to cultivate or increase crops or pepper yield in areas with salt affected soils and/or irrigate with saline waters. One approach to control salinity is leaching of soluble salts from root zone soil by giving additional amount of irrigation water known leaching fraction[6].

Saline conditions have been found to disrupt several physiological processes leading to reduction in growth[7,8] and in the fruit size and yield[9-11]. On the other hand, it has been reported that irrigating crop with saline water can improve its fruit quality[12-15].

The purpose of this study was to examine the effect of different level saline water application on the fruit yield and quality at the pepper (*C. annuum* L.).

EXPERIMENTAL

A greenhouse lysimeter study was carried out on April 18, 2005 at the Greenhouse Experimental Station, Faculty of Agriculture, Ondokuz Mayis University, Samsun, Turkey (altitude 180 m above sea level, 41º21' N and 36º15'E). Bafra Y17 pepper (*Capsicum annuum* L.) was selected for the experiment. The fruits of this well-known species are around Black-Sea region, tough and suitable for transporting. The pepper plants were grown in polyethylene lysimeters, 35 cm in diameter and 65 cm depth. Each lysimeter was filled air-dried soil and contained a single plant. The calculated amount of macro and micro nutrients were applied equally to all lysimeter. The characteristics of the experimental soil were given Table-1.

TABLE-1
SOIL CHEMICAL AND PHYSICAL TRAITS OF THE EXPERIMENTAL LYSIMETERS

Bulk density (g cm^{-3})	1.10	K^+ (me 100 g^{-1})	2.55
pH	8.00	Organic material (%)	3.03
EC (dS m^{-1})	2.17	Texture	Sandy loam
Ca^{2+} (me 100 g^{-1})	19.0	$CaCO_3$	2.94
Mg^{2+} (me 100 g^{-1})	8.50	Field capacity (%)	29.4
Na^+ (me 100 g^{-1})	4.34	Wilting point (%)	19.6

Irrigation water salinity levels were as follows: T_0 = 0.34 dS m^{-1} (control), T_1 = 1.00 dS m^{-1}, T_2 = 2.50 dS m^{-1}, T_3 = 4.00 dS m^{-1} and T_4 = 6.00 dS m^{-1}. Salinity levels were obtained by dissolving NaCl, $CaCl_2$ and $MgSO_4$ to tap (control) water. Ca:Mg ratio levels were 1:1 and 3:1 (Ca:Mg ratio will be called with O letter). The experiments were carried out in a fully randomized factorial experimental design with three replications. The sodium adsorption ratios (SAR values) for all lysimeters kept below one. The tap (control) irrigation water characteristics are given Table-2.

Evapotranspiration rates were determined by Class A Pan Evaporimeter and electronic soil-water probe with a digital scale at 1 d interval. Irrigation water amount depends of water loss in lysimeter soil profile.

TABLE-2
ANALYSIS OF TAP WATER USED IN TREATMENTS (T_0, CONTROL)

pH	8.20	HCO_3^- (me L^{-1})	2.20
EC_w (dS m^{-1})	0.34	CO_3^{2-} (me L^{-1})	–
Ca^{2+} (me L^{-1})	2.40	Cl^- (me L^{-1})	1.00
Mg^{2+} (me L^{-1})	1.20	SO_4^{2-} (me L^{-1})	0.21
Na^+ (me L^{-1})	0.58	SAR (me $L^{-1})^{1/2}$	0.43
K^+ (me L^{-1})	0.04	–	–

The plant biomass was determined by weighing the plants after being oven-dried at 70ºC. To evaluate the physical quality aspects of the pepper, the size, height and diameter of the fruits were measured while to evaluate the quality aspects.

SPSS statistical analysis software was used for analysis of variance and Anova and Duncan test. Significance of the effects of the salinity levels and ratios was statistically evaluated at $p < 0.05$ significance levels.

The Duncan test has been applied to determine how significant the differences between the averages of groups are.

RESULTS AND DISCUSSION

The results discussed the salinity effect on pepper fruit yield, height, diameter, plant height, plant diameters and dry matter in fruit, leaves and stem.

The average yield of pepper ranged between 319.56 g $plant^{-1}$ and 1748.11 g $plant^{-1}$ for the treatments T_4O_1 and T_0O_0, respectively (Table-3). Table-3 shows that increasing salinity from 0.34 dS m^{-1} to 6.00 dS m^{-1} resulted in a significantly decrease in yield from 1748.11 g $plant^{-1}$ to 319.56 g $plant^{-1}$ in treatments O_1 (Ca:Mg = 1:1). In treatments O_2 (Ca:Mg = 3:1) same salinity levels resulted in decrease in yield from 1748.11 g $plant^{-1}$ to 395.62 g $plant^{-1}$. Fig. 1 shows relation between different saline water and fresh yield. According to Duncan results between (T_3-T_4) and (T_1-T_2) have no significant difference ($p < 0.05$), between T_0 and other treatments the yield decreased significantly. There is no significant difference between O_1 and O_2 treatments.

TABLE-3
PEPPER FRESH YIELDS (g $plant^{-1}$) ACCORDING TO THE SALINITY AND Ca:Mg RATIO LEVELS

Irrigation water salinity levels (dS m^{-1})	O_1 (Ca:Mg = 1:1)	O_2 (Ca:Mg = 3:1)	Average
T_1	1096.03 a	815.62 a	955.83 B
T_2	948.56 a	1040.00 a	994.27 B
T_3	366.30 a	519.00 a	442.63 C
T_4	319.56 a	395.62 a	357.60 C
T_0 (Control)	1748.11 a	1748.11 a	1748.11 A

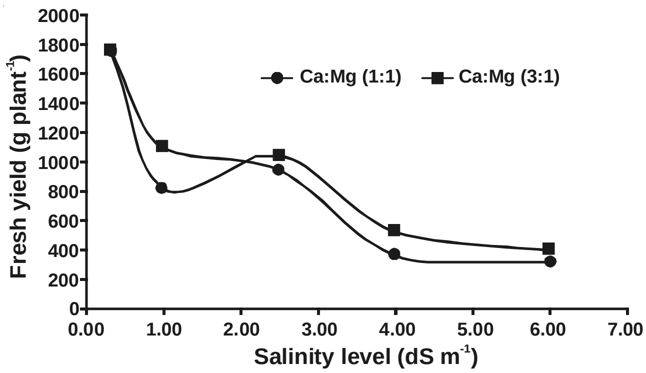

Fig. 1. Fresh fruit yield with different salinity levels

The pepper yield was effected only by salinity ($p < 0.05$ significance level). The yield did not show any response to Ca:Mg ratio levels.

TABLE-4
DUNCAN TEST RESULTS FOR THE FRUIT HEIGHT (cm) AND DIAMETER (mm) OF PEPPER FRUITS

Treatments	Fruit height (cm)			Fruit diameter (mm)		
	O_1 (1:1)	O_2 (3:1)	Average	O_1 (1:1)	O_2 (3:1)	Average
T_1	11.74 a	10.88 a	11.35 AB	14.71 a	13.42 b	14.06 BC
T_2	11.10 a	11.92 a	11.51 AB	14.87 a	14.00 b	14.44 B
T_3	10.36 a	10.89 a	10.62 BC	14.44 a	12.79 b	13.61 C
T_4	10.49 a	10.10 a	10.29 C	12.94 a	11.98 b	12.46 D
T_0 (Control)	12.44 a	12.44 a	12.44 A	15.36 a	15.36 b	15.36 A

Fruit height and diameter were determined for each fruit. The results are shown in Table-4. Ca:Mg levels did not have any effect on fruit height but Ca:Mg levels effected on fruit diameters significantly ($p < 0.05$). Salinity levels, however strongly affected the fruit height and diameters both and the parameters decreased with increasing salinity levels (Fig. 2). Both parameters exhibited similar response to salinity levels.

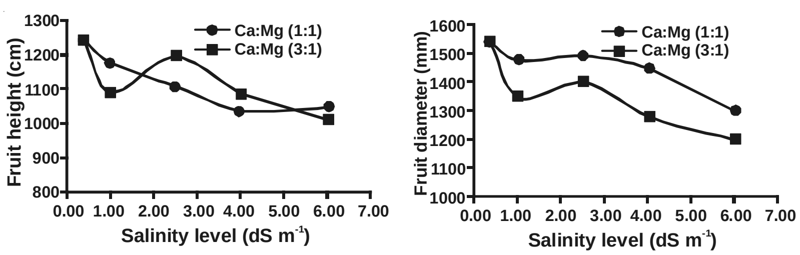

Fig. 2. Fruit height (left) and fruit diameter (right) with different salinity levels

Fruit quality and salinity effect were determined by oven-dry mass. Fresh crop dried in oven until weight become stable than ratio of fresh mass and dry mass presented as a per cent. Table-5 shows the dry fruit matter, dry leaves matter, dry stem matter. Ca:Mg ratio has no significant difference dry fruit matter and dry leaves matter but there is a significant difference dry stem matter ($p < 0.05$). Salinity levels, however strongly affected the dry fruit matter, dry leaves matter, dry stem matter ($p < 0.05$). Increasing salinity resulted in a significantly decrease in dry stem matter, however increasing salinity resulted in a significantly increase dry fruit matter and dry leaves matter ($p < 0.05$) can be seen in Fig. 3.

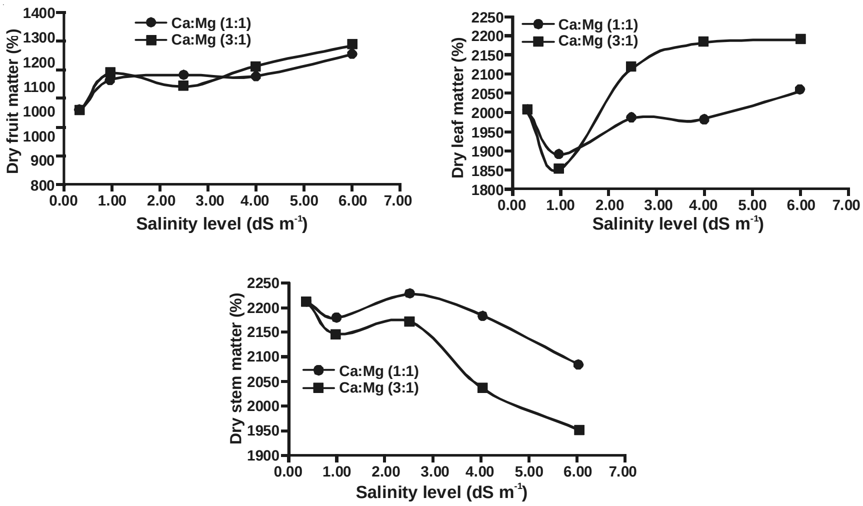

Fig. 3. Fruit dry matter (left upper), leaf dry matter (right upper) and stem dry matter (down) with different salinity levels

TABLE-5
DUNCAN TEST RESULTS FOR DRY FRUIT MATTER, DRY LEAVES MATTER, DRY STEM MATTER (%) OF PEPPER

Treatments	Dry fruit matter			Dry leaves matter			Dry stem matter		
	O_1 (1:1)	O_2 (3:1)	Average	O_1 (1:1)	O_2 (3:1)	Average	O_1 (1:1)	O_2 (3:1)	Average
T_1	11.64 a	11.89 a	11.76 B	18.88 a	18.47 a	18.67 A	21.85 a	21.51 b	21.68 A
T_2	11.82 a	11.41 a	11.61 B	19.84 a	21.17 a	20.50 A	22.35 a	21.79 b	22.07 A
T_3	11.76 a	12.13 a	11.95 B	19.82 a	21.83 a	20.82 A	21.92 a	20.40 b	21.16 AB
T_4	12.53 a	12.85 a	12.70 A	20.58 a	21.94 a	21.26 A	20.90 a	19.54 b	20.22 B
T_0 (Control)	10.60 a	10.60 a	10.60 C	20.05 a	20.05 a	20.05 A	22.21 a	22.21 a	22.21 A

Conclusion

The effect of different salinity and Ca:Mg ratio levels on yield, biomass and dry matter of a Bafra Y17 pepper (*Capsicum annuum* L.) were evaluated. The salinity levels had statistically significant effects on all parameters, Ca:Mg ratio levels had significant effect on fruit diameters and dry stem matters. Increasing salinity levels caused a certain decrease in all of the examined parameters, except dry fruit matter and dry leaves matter.

REFERENCES

1. P. Botia, J.M. Navarro, A. Cerda and V. Martines, *Eur. J. Agron.*, **23**, 243 (2005).
2. A. Tedeschi and R. Dell Aquila, *Agric. Water Manag.*, **77**, 308 (2005).
3. Z. Flagella, V. Cantore, M.M. Giuliani, E. Tarantino and A. De Caro, *Rec. Res. Dev. Plant Biol.*, **2**, 155 (2002).
4. A. Hamdy, M. Lasram and C. Lacirignola, *C.R. Acad. Agric.*, **81**, 47 (1995).
5. Z. Flagella, M.M. Giuliani, T. Rotunno, R. Di Catarina and A. De Caro, *Eur. J. Agron.*, **21**, 267 (2004).
6. S.M.E. Satti and M. Lopez, *Commun. Soil Sci. Plant Anal.*, **15-16**, 2807 (1994).
7. T.J. Flowers, P.F. Troke and A.R. Yeo, *Ann. Ref. Plant Physiol.*, **28**, 89 (1977).
8. S.M.E. Satti and R. Ahmad, *Pak. J. Bot.*, **24**, 35 (1992).
9. P. Adams, *J. Hort. Sci.*, **66**, 201 (1991).
10. S.M.E. Satti, M. Lopez and F.A. Al-Said, *Commun. Soil Sci. Plant Anal.*, **25**, 5 (1993).
11. E. Yurtseven, G.D. Kesmez and A. Unlukara, *Agric. Water Manag.*, **78**, 128 (2005).
12. Y. Mizrahi, *Plant Physiol.*, **69**, 966 (1982).
13. P. Adams, *Grower*, **107**, 25 (1987).
14. X. Hao, A.P. Papadopoulas, M. Dorais, D.L. Ehret, G. Turcotte and A. Gosselin, *Acta Hort.*, **511**, 285 (2000).
15. A. Inal, *Turk. J. Bot.*, **26**, 285 (2002).

(*Received*: 1 September 2006; *Accepted*: 30 January 2007) AJC-5364