J. Agric. Sci. Mansoura Univ., 27(11): 7927 - 7934, 2002

EFFECT OF INTERVAL AND RATE OF SALINE WATER APPLICATION ON CUCUMBER YIELD UNDER GREENHOUSE CONDITIONS IN GAZA DISTRICT

Tubail, Kh.M.
Soil Sciences Dept., Faculty of Agriculture, Al-Azhar University. P. O. Box 1277. Gaza (PNA) ktubail@hotmail. com

ABSTRACT

The effect of rate and interval of saline water application on yield, element content of leaves and fruits as well as on soil characteristics were studied with cucumber (*Hybrid extram*) for two seasons under greenhous conditions. Cucumber seedlings were grown in 20-liter pots filled with sandy loam soil containing 12% (v/v) compost and irrigated firstly with fresh water and three weeks later with saline water (EC = 3.2 dS/m) in two rates, namely 100% of IR and 125% of IR within each irrigation rate the plants were irrigated daily, every other day and every third day. The cucumber fruits were collected and weighed regularly. The fruit yeild increased with increasing irrigation rate but decreased in the second season within the lower irrigation rate. An increase in yield with the increase of irrigation interval was also observed. Leaves and fruits analysis showed a dcrease in Na concentration with increasing of irrigation rate. The soil analysis showed an increase in Na, Cl, EC and SAR values in the second season, wherase these parameters decreased with increasing the rate of irrigation water for all treatments.
Keywords: Cucumber, saline water, irrigation rate, irrigation interval, fruit yield

INTRODUCTION

Gaza Strip is located in the southern part of the Mediterranean coastal and considered as a semi-arid region with a rainfall of about 430 mm/year in the north and 230 mm/year in the southern part near Egyptian borders. The limited fresh water aquifer which is severely over pumped since 1948 led to flow of salt water from the sea and salinization of a wells specially in the southern part of region (Palestinian Water Authirity (PWA), 2000). Through the irrigation process, salts are continually added to the soil causing a secondary salinization of soil; this leaded to a poorer plant growth and consequently reduction in yield. This reduction is attributed to the higher osmotic water potential, which develops in the soil when salinity rises (Bernstein, 1975 and Mass and Hoffman, 1977).

Several developing countries are today facing many problems such as the huge increased population and unfavorable agricultural practices.Gaza's population is rapidly growing and expected to be 2.156 Million in 2020 (Palestinian Central Bureau of Stastics (PCBS), 2000).

The demand for good water quality to use for different purposes is becomeing a more acute problem. In the situation of limited supply and increasing demand of water, high priority would be given to domestic use, which include drinking and sanitation requirements. The scarcity of good water quality which has been considered as the most important factor limiting the growth of agriculture prodution encourages the utilization of brackish water. Cucumber is an economical crop grows widely in open field and under green house conditions in Gaza Strip (Ministry of Agriculture (MOA), 2000). Ayers and Westcot (1976) classified water for irrigation uses according to degree and kind of problems likely to be encountered when using water with certain quality parameters. In fact the actual suitability of a given water for irrigation depends very much on the specific condition of use (crop grown, soil properties, irrigation management practices and climatic conditions) and on the relative economic benefit (Rhoades and loveday 1990). Irrigation scheduling strategies should aim for applying water at fairly routine intervals and amounts to prevent over application of water, while minimizing yield loss due to water shortage or drought stress (Evans et al.,1996). The irrigation frequency for optimum plant response using saline water has not always been agreed upon due to interaction of soil type, level of salinity and plant salt tolerance in question (Devitt, 1989). Irrigation scheduling should allow both good crop yield and adequate leaching of the soil when saline water is used. Decreasing the interval between irrigations (increasing the frequency of irrigation) could maintain a more constant moisture content of the plant medium (Ayers&Westcot, 1976).

Actually, little has been done in research relating to the use of saline water in agricultural production in Gaza Strip.

The present work aimes to evaluate the effects of frequency and rate of saline water application on cucumber yield components and on soil characteristics under greenhouse condition in Gaza Strip.

MATERIALS AND METHODS

The soil used in the present experiment was taken from surface layer (0-30 cm) of soil at southern part of Gaza Strip which considered as a light textured sandy loam soil. The irrigation water applied was brought from the southern part of Gaza Strip with an EC 3.2 dS/m. Seedlings of cucumber (*hybrid extram*) were planted in plastic pots of 20-liter volume having free drainage holes and grown in a 500 m^2 plastic greenhouse. Four replicates of each treatment were irrigated initially for two weeks with fresh water, then irrigated with saline water by drip system (4l/h) and fertilized according to recommendations of MOA.

The experiment was conducted at University Research Farm using two rates of applied irrigation water namely Q_1 (100%) and Q_2 (125%) of irrigation requirements (IR) calculated according to Class A-evaporation pan method (Doorenbos and Pruitt, 1992). Irrigation of plants with saline water started after plant establishment with fresh water according to the irrigation scheduling 1 day, 2 days and 3 days irrigation intervals (Table1), in which the plants received the same amount of of irrigation water. The fertilization program started when plants become one month old. The cucumber fruits have been harvested firstly when plants became 40 days old and continued for about 50 days to the end of growth season.

Analytical methods

Leave and fruit samples were collected at the end of the experiment for analysis. Plant samples were washed with tap water followed by 0.1 N HCl and the with distilled water. The plant samples were dried in a forced air oven at 65 C^0 and ground in a mill. 0.5 gram of dried plant sample was ashed in a muffle furnace at 550 °C for at least 4 hours, cooled and wetted with few drops of deionized water; 5 ml of nitric acid (1:3) was added to each sample and left to evaporate. The ash sample was then dissolved in 5 ml HCl (1:3) and the solution was quantitavely transferred to a 50-ml volumetric flask using hot distilled water and filtered. The concentration of Na, K and Ca were estimated by a flame photometer and Mg concentration by using atomic absorption spectrophotometer. Soil samples were air-dried, sieved and stored in plastic bags. Soil extract of a saturated paste was prepared for chemical analysis. EC and pH were measured using specific meters; Na was photometricaly determined; Cl, Ca and Mg were titrimetricaly determined, wherase SAR value was calculated.

Table (1): Irrigation scheduling.

Irrigation rate	Irrigation frequency (days)					
	1	2	3	4	5	6
Q1	1S	1S	1S	1S	1S	1S
	2S	Non	2S	Non	2S	Non
	3S	Non	Non	3S	Non	Non
Q2	1S	1S	1S	1S	1S	1S
	2S	Non	2S	Non	2S	Non
	3S	Non	Non	3S	Non	Non

Notes:
1S= daily, 2S = 2×1S each 2 days and 3S = 3×1S each 3 days

RESULTS AND DISCUSSION

Properties of the used soil and irrigation water are shown in Table 2. The used soil is nonsaline – non alkali, while the water used is considered as moderatelty saline water according to Doorenbos and Pruitt (1992), Since the ECis 3.2 DS/m and S.A.R.value is 10.1.

Table (2): Composition of soil and water used for experiment.

Type	pH (1:1)	EC dS/m	Na me/l	Ca me/l	Mg me/l	Cl^- me/l	$CaCO_3$ %	SAR
Soil	7.9	2.2	5.4	8.9	4.6	14	4.1	2.2
Water	---	3.2	21.3	4.4	4.4	19.8	----	10.1

Data presented in Table 3 lists the chemical analysis of soil samples taken at the end of two seasons. Very slight reduction in pH with increasing of irrigation rate was observed; wherase it increased in the second season compared with the first season. EC, Na, Cl and SAR values increased significantly in the second season due to the accumulation of salinity with time, wherase these values decreased with increasing the rate of applied water in all treatments; this might be due to the probably leaching effect. The soil irrigated with higher rate (Q2) within treatment C, in which more water was applied every 3 days had lower salinity. This might be due to salinity control caused by adequate leaching, which assure downward flux of water and salts below the crop root zone as indicated by Rhoades and Loveday (1990).

Table (3) : Some chemical properties of used soil withen and after both of the two growing seasons.

Soil Properties	Growth Season	Irrigation intervals					
		A		B		C	
		Q1	Q2	Q1	Q2	Q1	Q2
PH	I	7.64	7.65	7.51	7.47	7.73	7.53
	II	7.78	7.70	7.62	7.52	7.80	7.56
EC	I	3.42	3.14	5.11	4.92	3.68	2.78
	II	4.79	4.29	6.44	6.23	4.88	3.42
Na	I	31.05	27.06	35.28	27.20	23.81	18.76
	II	50.11	45.25	39.08	34.05	29.31	27.20
Cl	I	29.00	22.80	38.40	27.70	32.30	26.80
	II	39.80	36.70	41.20	36.30	38.50	36.30
Ca+Mg	I	36.10	35.21	34.41	33.81	35.14	36.32
	II	40.40	34.80	36.32	37.06	34.82	36.18
SAR	I	7.31	6.45	8.51	6.62	5.69	4.40
	II	11.38	10.85	9.17	7.92	7.02	6.40

A: one day B: two days C: 3days

The yield was decreased in the second season for both irrigation rates Q1 and Q2 (Table 4). This may be due to the increased soil salinity deposited from the previous season. In case of lower irrigation rate (Q1), the yield increased with increasing irrigation intervals, due to the probably leaching effect causing by the addition of two and three folds of irrigation water in one time. This is in accordance with Ayers and Westcot (1976), who reported that applying more irrigation water than can be used by the crop and lost by evaporation assure that salt removal takes place by leaching through the root zone. At the same time, there are no differences in the cucummber yield within the three intervals in the case of the higher irrigation rate (Q_2). Concerning average weight of fruit, data indicated that it was significantly higher in case of the higher irrigation rate (Q_2) either in the first or second growing season (Table 4).

Table (4): Yield and average weight of one fruit in the two growing seasons

Treatment	Growth season	Yield (Kg)		Average weight of one fruit, (g)	
		Q1	Q2	Q1	Q2
A	I	34.59 (1.77)*	44.09 (2.14)	58.2 (1.84)	66.2 (2.60)
	II	23.15 (1.37)	31.79 (0.90)	63.9 (1.75)	69.2 (1.05)
B	I	41.15 (1.85)	43.25 (1.74)	56.3 (1.80)	61.4 (1.71)
	II	27.76 (1.47)	32.86 (1.78)	60.2 (2.94)	68.4 (2.64)
C	I	42.31 (1.37)	42.72 (1.47)	55.6 (1.44)	58.3 (2.07)
	II	26.46 (1.42)	31.90 (1.61)	61.1 (2.33)	70.5 (2.47)

* standard deviation

Table (5): Elemental concentration. (%) of cucumber leaves in the two growing seasons

Treatment	Growth Season	Na		K		Mg		Ca	
		Q1	Q2	Q1	Q2	Q1	Q2	Q1	Q2
A	I	1.05 (0.08)	0.89 (0.11)	1.48 (0.12)	1.40 (0.14)	1.84 (0.15)	1.52 (0.07)	5.55 (0.24)	5.03 (0.29)
	II	0.84 (0.12)	0.78 (0.15)	1.06 (0.02)	1.04 (0.17)	2.79 (0.17)	2.89 (0.15)	7.42 (032)	7.09 (0.33)
B	I	1.12 (0.13)	1.12 (0.19)	1.47 (0.11)	1.47 (0.20)	1.62 (0.16)	1.38 (0.16)	5.16 (0.22)	4.25 (0.30)
	II	0.93 (0.12)	0.79 (0.05)	0.99 (0.06)	0.94 (0.08)	3.07 (0.05)	3.07 (0.05)	7.96 (0.27)	7.64 (0.41)
C	I	1.20 (0.03)	0.87 (0.04)	1.34 (0.01)	1.58 (0.03)	1.64 (0.17)	1.44 (0.20)	5.10 (0.07)	5.02 (0.20)
	II	0.97 (0.09)	0.78 (0.05)	1.02 (0.10)	0.98 (0.07)	2.84 (0.21)	2.75 (0.12)	7.50 (0.30)	7.45 (0.39)

* standard deviation

Table (5) lists the elemental analysis of cucumber leaves for two seasons. The results clearly demonstrate that Na and K contents decreased in the second season, where Ca and Mg content increased compared with the first season. No considerable differences were noticed among the different treatments. Regarding the elemental analysis of the fruits, the results of Table (6) showed that markedly increase in Na-content in the second season was observed and Na was higher for treatments B and C than for treatment A. The analysis of Mg showed a slight increase, wherase a slight decrease in Ca concentration has been noticed in the second season. The application of high rate of irrigation water (Q_2) reduced the concentration of Na in leaves and fruits for the two growth seasons, which is clearly associated with soil analysis shown in Table (3). Ca and Mg accumulations were markedly higher in leaves than fruits, wherase the opposite trend was occurred for K. There was no difference in K concentration due to increasing amount of irrigation water applied.

Na/K- and Na/Ca-ratios in leaves and fruits are illustrated in Figs. 1-4. These results showed an increase in Na/K-ratio in the second season compared with the first season. The Na/Ca–ratio in fruits showed the same phenomenon. Na/Ca-ratio in leaves decreased in the second season. It is also, noticed that the Na/K- and Na/Ca –ratio in leaves and fruits decreased with increasing irrigation rate.

Table (6): Elemental concentration (%) of cucumber fruits

Treatment	Growth season	Na		K		Mg		Ca	
		Q1	Q2	Q1	Q2	Q1	Q2	Q1	Q2
A	I	0.96 (0.11)	0.92 (0.09)	2.76 (0.27)	3.12 0.15)	0.33 0.03)	0.23 (0.02)	0.38 0.03)	0.36 0.05)
	II	1.37 (0.15)	1.18 (0.14)	3.36 (0.37)	2.74 (0.24)	0.34 0.03)	0.45 0.06)	0.36 0.04)	0.33 0.07)
B	I	1.19 0.06)	1.13 0.11)	2.29 0.13)	3.75 (0.04)	0.26 0.01)	0.31 0.01)	0.39 0.05)	0.42 0.03)
	II	1.36 0.10)	1.30 0.13)	3.09 (0.11)	3.40 0.15)	0.31 0.01)	0.34 0.01)	0.35 0.02)	0.39 0.04)
C	I	1.10 0.10)	1.01 0.03)	3. 43 0.14)	3.71 0.22)	0.25 0.01)	0.32 0.05)	0.32 0.03)	0.44 0.06)
	II	1.37 0.23)	1.36 (0.14)	3.38 0.39)	3.25 0.35)	0.29 0.02)	0.33 0.01)	0.31 0.04)	0.43 0.03)

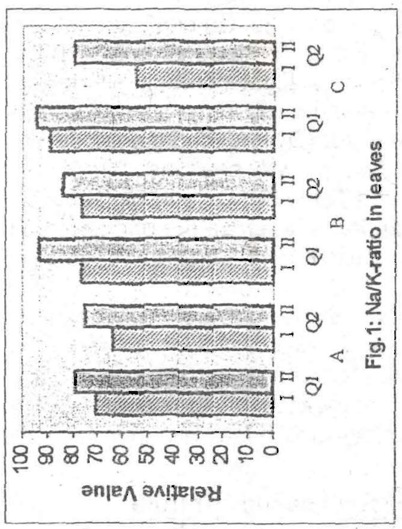

Fig.1: Na/K-ratio in leaves

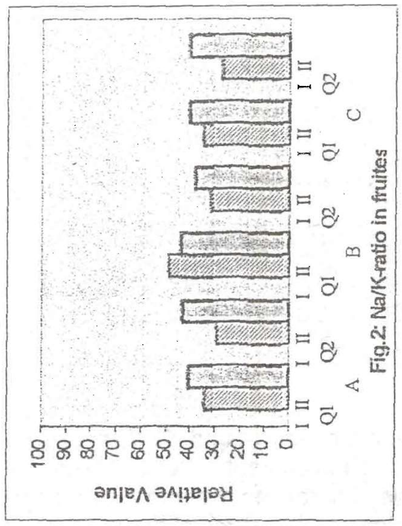

Fig.2: Na/K-ratio in fruites

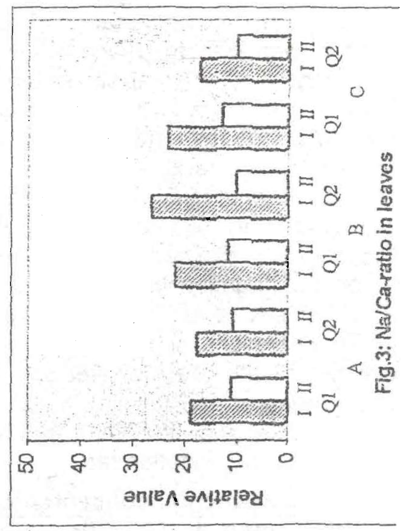

Fig.3: Na/Ca-ratio in leaves

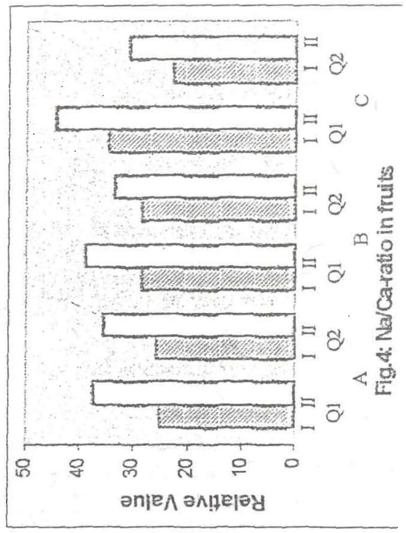

Fig.4: Na/Ca-ratio in fruits

ACKNOWLEDGMENT

I would like to express my thanks to luxenbourg Agricultural Project at Al-Azhar University, Gaza for funding this research work and to Institutue for Plant Nutriation, Hohenheim University, Germany for plant analysis. Also, my thanks to Mr. Eng. Ismail, J. and El-Zanien , O. for their kind help.

REFERENCES

Ayers, R. S. and D. W. Westcot (1976). Water quality for agriculture. FAO Irrig. and Drain. paper No. 29, Rome, Italy.

Bernstrin, L. (1975). Effects of salinity and sodicity on plant growth. Annu. Rev. Phytopathol., 13:295-312.

Devitt, D. A. (1989). Bermudagrass response to leaching fraction irrigation salinity and soil types. Agron J., 81:893-901.

Doorenbos, J. and W.O. Pruitt (1992). Crop water requirments. FAO Irr. Drain. Paper 24, Rome . Italy.

Evans, R., Sneed, R. E. and D. K. Cassel (1996). North Carolina Cooperative Extension Service, Publication No. AG 452-4.

KafKaki, U. C. (1993). Plant nutrition under saline conditions. Fertilizers and Agriculture, 95:3-17.

Mass, E. V. and G. J. Hoffman (1997). Crop Salt tolerance current assessment. J. Irrig. Drain. Div. Proc. Am. Soc. Civil Eng., 103:115-134.

Mizrahi, Y. and D. Pasternate (1985). Effect of salinity on quality of various agriculture crops. Plant and Soil 89:301–307.

MOA (2000). Ministry of Agriculture Report, Gaza. PNA.

PCBS (1999). Palestinian Central Bureau for Statistics.

PWA (2000). Coastal Aquifer Management Program for Gaza Report, Palestinian Water Authirity. Gaza, PNA.

Okasha M. K. (1995). Results of demographic study in water institutions and water laws in palestine water consulting group, Gaza.

Rhoades, J. D. and J. Loveday (1990). Salinity in irrigated agriculture. Agronomy Monograph No. 30 P. 1089. Madison, USA.

Sonneveld, C and A. M. van der Burg (1991). Sodium chloride salinity in fruit vegetable crops in soilless culture. Neth. J. Agric. Sci, 39(2): 115 – 122

Sonneveld, C. and S. J. Voogt (1978). Effect of saline irrigation water on greenhouse cucumber. Plant and Soil, 49 (3): 595 – 606.

Tanji, K. K. (1990). Agriculture salinity assessment and management. American Socially of Civil Engineers. Manual and Reports on engineering practice No. 71.

تأثير معدلات وفترات الري باستخدام المياه المالحة على انتاجيـــة الخيـــار تحـت ظروف الزراعة المحمية في قطاع غزة

خليل محمود طبيل – كلية الزراعة – جامعة الازهر – غزة

تم دراسة تأثير معدلات وفترات الرى باستخدام مياه مالحة على محصول الخيـار ومحتوى الأوراق والثمار من العناصر وكذلك على خصائص التربة لموسمين زراعييــن. أجريت التجربة فى البيوت المحمية حيث تم زراعة شتلات الخيار فى تربة طميية رمليــة فى أصص ذات حجم ٢٠ لتر.

تم رى الشتلات بالماء العذب فى بداية التجربة ثم بالمياه المالحه (درجة التوصيل الكهربى ٣,٢ ديسمنز/م) وبمعدلات ١٠٠%، ١٢٥% من الاحتياجات المائية المحســوبة، وكانت فترات الرى كل يوم وكل يومين وكل ثلاث أيام.

أوضحت النتائج زيادة المحصول مع زيادة كمية ماء الرى، كما لوحظ تنــاقص تركيز الصوديوم فى الأوراق والثمار. ولقد بينت النتائج أيضا زيادة التوصيل الكهربى فى عينات التربة وكذلك زيادة قيم الصوديوم والكلوريد ونسبة ادمصــاص الصوديــوم بينمـا تناقصت هذه القيم مع زيادة معدلات الرى.