PAMUKKALE ÜNİVERSİTESİ MÜHENDİSLİK FAKÜLTESİ
PAMUKKALE UNIVERSITY ENGINEERING COLLEGE
MÜHENDİSLİK BİLİMLERİ DERGİSİ
JOURNAL OF ENGINEERING SCIENCES
YIL : 1997
CİLT : 3
SAYI : 2
SAYFA :365-369

EFFECT OF IRRIGATION WATER QUALITY ON THE YIELD OF *MENTHA PIPERITA*

Ahmet ÖZTÜRK
Ankara Üniversitesi, Ziraat Fakültesi, Tarımsal Yapılar ve Sulama Bölümü, Ankara

ABSTRACT

This study was carried out to determine the effect of water quality on mentha yield in plastic pots under greenhouse conditions. There were five different treatments as irrigation water quality which were 0.25, 1, 2, 4 and 6 dS/m. An increase in irrigation water salinity decreased mentha yield, dramatically. The average yield obtained from the pots were found as 40.723 g, 28.46 g, 25.36 g, 17.55 g and 14.82 g at 0.25, 1, 2, 4 and 6 dS/m irrigation water salinity levels, respectively. The relationship between electrical conductivity of irrigation water and yield showed that electrical conductivity values of 0.90, 2.25, 4.50 and 9.00 dS/m caused 10 %, 25 %, 50 % and 100 % reduction in the yield, respectively. Total ash contents of plants were affected by irrigation water salinity. Total ash contents were found as 11.70 %, 11.94 %, 12.24 %, 16.34 % and 18.23 % at 0.25, 1, 2, 4 and 6 dS/m irrigation water salinity levels, respectively.

Key Words: Salinity, Irrigation water quality, Peppermint

SULAMA SUYU KALİTESİNİN NANE BİTKİSİ (*MENTHA PIPERITA L.*) VERİMİNE ETKİSİ

ÖZET

Bu çalışma, farklı kalitelerdeki sulama sularının nane verimi ve toplam mineral madde içeriği üzerindeki etkisini belirlemek amacıyla, plastik saksılarda, tesadüf parselleri deneme tertibine göre, sera şartlarında yürütülmüştür. Araştırmada sulama suyu olarak, 0.25 dS/m elektriksel iletkenliğe sahip şehir şebekesi suyu ile bu suya çeşitli tuzlar katılarak oluşturulan 1, 2, 4 ve 6 dS/m elektriksel iletkenliğe sahip sular kullanılmıştır. Sulama suyu tuzluluğunun artışına bağlı olarak verimde % 1 önemlilik düzeyinde azalmalar gözlenmiştir. Verim değerleri 0.25, 1, 2, 4 ve 6 dS/m tuzluluk seviyeleri için sırasıyla 40.72, 28.46, 25.36, 17.55 ve 14.82 g/saksı olarak elde edilmiştir. Sulama suyu elektriksel iletkenliği-verim ilişkisinden, % 10, % 25, % 50 ve % 100 verim azalmasına neden olacak elektriksel iletkenlik değerleri sırasıyla 0.90, 2.25, 4.50 ve 9.00 dS/m olarak belirlenmiştir. Bitkilerin mineral madde içeriğindeki değişmeler de % 1 önemlilik düzeyindedir. Mineral madde içeriği değerleri 0.25, 1, 2, 4 ve 6 dS/m tuzluluk seviyeleri için sırasıyla % 11.70, % 11.94, % 12.24, % 16.34 ve % 18.23 olarak belirlenmiştir.

Anahtar Kelimeler: Tuzluluk, Sulama suyu kalitesi, Nane

1. INTRODUCTION

In many countries to find enough useable water is becoming harder, which forced people to use waste water. But, use of waste water has some negative effects on environment and people health.

Irrigation with waste water causes dramatic decreases in plant yield and crop production has been greatly affected by soil salinity. In the world, nearly 230 million ha of the irrigated area supplies almost half of the world's food (Mc William, 1986). Use of irrigation water showing high degrees of salinity may result in an increase in the salinity of this large area.

The response of the plants to waste water varies as they show different tolerance levels to salinity. Whilst a salinity level may not cause any yield reduction in a plant species, it may reduce the crop yield to zero in other plant species. Generally, all plants tolerate up to a certain level of salinity without any yield reduction. However, after this level, an increase in salinity results in less yield production (Maas et al., 1977). The response of a plant to salty conditions also varies at different growth stages (Bernstein, 1970).

Mentha has a very important place in pharmacy as it contains eteric oils like menthon, menthol and tanen. It can be put into dishes and salads and used as tea. Mentha growth areas are getting larger and larger in many countries, however, it is grown in small areas in Turkey (Oraman, 1968; Günay, 1984; Akgül, 1993).

Effect of water salinity has been reported for many crop plants such as alfalfa (Keck et al., 1984), cotton (Howel et al., 1984), pea (Lal, 1985) and tomato (Vinten et al., 1986). In all these reports crop yield was drastically reduced at higher salt concentrations. Although mentha is a useful plant in pharmacy, effect of water salinity on mentha plant has not so far been studied. This paper reports the effect of irrigation water salinity on mentha yield and total ash content.

2. MATERIALS AND METHODS

2. 1. Materials

This research was carried out in greenhouse. The soil used in the study was obtained from the soil surface of Agricultural Faculty research field. Soil was dried in greenhouse and was sifted by the 2 mm sieve. Dried and sifted soil mixed with fine sand in the ratio of 2/1 and was transferred into the pots. Eight liters pots were used in the experiment.

Pots were treated with five different irrigation water. The electrical conductivity of tap water was 0.25 dS/m and used as a control. The other treatments were prepared from tap water by adding NaCl, $CaCl_2$ and $MgCl_2$ and their electrical conductivity values were 1, 2, 4 and 6 dS/m.

2. 2. Methods

There were five treatments and tree replications in the study which was carried out in randomized plot design. The plants were propagated using branch and root cuttings. At the beginning of the research, all pots were brought to field capacity and weighted. The plants were irrigated by weighing the pot and adding the lack of water from the field capacity. Weight of the plant material above soil level was evaluated as yield. To determine the total ash, plants were burnt at 550 ^{o}C for 48 hours as described by Kacar (1972).

Each treatment had three replicates consisting of eight liters pots each containing three plants. Data were statistically analyzed by analysis of variance (ANOVA), regression analysis and Duncan's Multiple Range test (Düzgüneş et al., 1987).

3. RESULTS

The soil used in the experiments was analyzed at the beginning of the research. Some physical and chemical features of the soil are shown in Table 1. As it can be seen from the table, field capacity and wilting point values are found to be low. The reason for this due to mixing sand into the soil.

Irrigation water treatments that have five different salinity levels were analyzed chemically and the results are summerized in Table 2.

Table 1. Some Chemical and Physical Properties of the Soil

Field capacity (%)	Wilting point (%)	Texture: Silty-loam Sand %	Silt %	Clay %	Volumetric weight (g/cm^3)	Total salt (%)	$CaCO_3$ (%)
12.4	7.7	69.0	20.5	16.5	1.38	0.054	8.6
	Cations (me/l)						
EC (dS/m)	Ca	Mg		Na	K		Total
1.16	8.25	0.29		3.75	0.77		13.06
	Anions (me/l)						

pH	CO_3	HCO_3	Cl	SO_4	Total
8.87	2.16	2.97	1.75	6.18	13.06

Each value is the mean of 3 replications

Table 2. Chemical Analysis Results of Irrigation Water

Subject	pH	EC	Cations (me/l)				Anions (me/l)					SAR
		(dS/m)	Na	K	Ca+Mg	Total	CO_3	HCO_3	Cl	SO_4	Total	
T_1	7.3	0.25	0.42	0.04	1.82	2.28	0	1.42	0.50	0.36	2.28	0.44
T_2	7.8	1.02	1.20	0.07	8.19	9.46	0	1.42	7.50	0.54	9.46	0.59
T_3	7.8	2.05	1.60	0.09	14.90	16.59	0	1.42	7.50	7.67	16.59	0.59
T_4	7.6	4.04	2.21	0.12	33.49	35.82	0	1.42	7.50	26.90	35.82	0.55
T_5	7.6	6.00	2.50	0.14	49.14	51.78	0	1.42	7.50	42.86	51.78	0.50

Each value is the mean of 3 replications

Since SAR value of the control treatment was found 0.44, in other treatments SAR values were kept less than 1

3. 1. Effect of Different Water Salinity Levels on Mentha Yield

The mentha yield results obtained after irrigation with water containing five different salinity levels are shown Table 3.

Table 3. Effect of Water Salinity Levels on Mentha Yield and Mineral Material Content

Salinity levels (dS/m)	Mean yield (g/pot)		Mean total ash (%)	
0.25	40.73	A[1]	11.70	B[1]
1	28.46	AB	11.94	B
2	25.36	B	12.24	B
4	17.55	B	16.34	A
6	14.82	B	18.23	A

Each value is the mean of 3 replications each with 3 plants

[1] Values within a column followed by the different letters are significantly different at the 0.01 level

According to the results, increase in water salinity resulted in dramatic reductions in mentha yield ($p < 0.01$). For example, control treatment (0.25 dS/m) produced 40.73 g yield, whereas 6 dS/m gave 14.82 g mentha yield. Regression analysis were made between the salinity levels of irrigation water and mentha yields. Results of regression analysis showed that the relationship between salinity levels and yields was found statistically significant ($p < 0.01$, $F_{(1,13)} = 27.04$, $r = -0.822$).

The relation was found as

$$Y = 36.0 - 4.0\ S \qquad (1)$$

Where; Y: Mentha yield (g/pot)
S: Salinity level (dS/m)

The relationship between irrigation water salinity and mean mentha yield is shown in Figure 1 as observed and estimated values.

Depending on the relationship between salinity and yield, proportional yield decreases were given in Table 4. These data indicate that mentha yield was drastically reduced at high electrical conductivity of irrigation water and soil saturation extract.

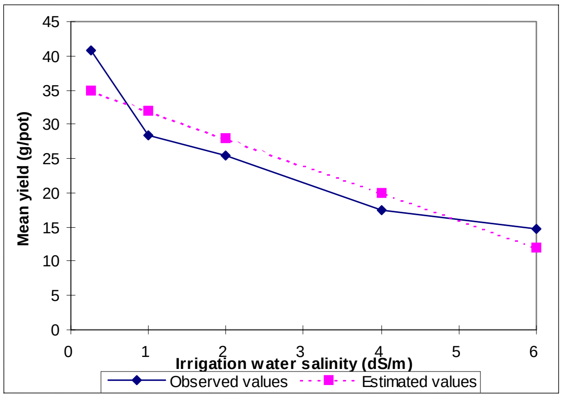

Figure 1. Irrigation water salinity-mentha yield relationship

Table 4. Salinity Levels for Certain Proportional Yield Decrease

	Proportional yield decrease			
	% 10	% 25	% 50	% 100
Electrical conductivity of irrigation water (dS/m)	0.90	2.25	4.50	9.00
Electrical conductivity of soil saturation extract (dS/m)	1.35	3.38	6.75	13.5

3. 2. Effect of Different Salinity Levels on Total Ash

Plants grown under different salty conditions obtain different amount of salts from the soil. Therefore, plants contain different amount of salt in their bodies. This salt content effect the plants negatively. To determine the amount of salts in plant body, organic material was burnt out so that only the salts remained. These remained salts are called total ash (Kacar, 1972). Total ash values of mentha plants depending on water salinity are given in Table 3.

The results of variance analysis made for total ash values showed that the salinity levels of irrigation water affected the salt content of plant at statistically significant levels ($p < 0.01$). Increase in water salinity stimulated total ash content of mentha. Regression analysis were made between the salinity levels of irrigation water and mineral material contents of mentha. The results of regression analysis indicated that the relationship between salinity levels and mineral material contents was statistically important ($p < 0.01$, $F_{(1,13)} = 97.88$, $r = 0.94$). The relation was found as

$$MM = 10.8 + 1.25\ S \qquad (2)$$

Where; MM: Mineral material contents of plant (%)
S: Salinity level (dS/m)

The relationship between water salinity level and mineral material contents of mentha is shown in Figure 2. In the figure the observed and estimated mineral material contents were plotted against salinity levels.

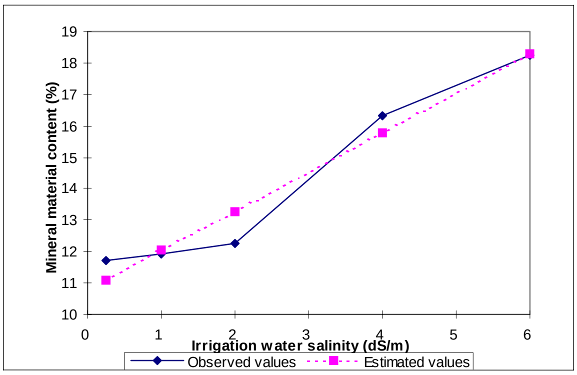

Figure 2. The relationship between irrigation water salinity and mineral material contents of mentha

4. DISCUSSION AND CONCLUSIONS

Previous studies showed that irrigation water salinity have resulted in significant decrease in yield of many crop plants of different species (Keck et al., 1984; Lal, 1985; Vinten et al., 1986). In the present study *Mentha piperita* plant was also effected significantly by irrigation water salinity for yield and total ash values. There were 10 %, 25 % and 50 % yield reductions in the salinity levels of 0.90 dS/m, 2.25 dS/m and 4.50 dS/m respectively. These results indicated that mentha plant can be classified as midsensitive crop depending on the classification system given by Ayers and Westcot (1989).

Therefore, mentha that is grown especially as medicine and spices plant, requires special irrigation conditions. Irrigation water quality must be adequate in order to grow mentha without yield reduction. If salinity level of irrigation water is high, salt concentration of soil solution will be high. Therefore, the plant will take more salts from the soil and will be effected negatively. If there is no suitable water for irrigation, leaching of soil can be a solution to grow mentha safely.

5. REFERENCES

Akgül, A. 1993. Nane, Baharat Bilimi ve Teknolojisi., Gıda Teknolojisi Derneği Yayınları, Ankara. 15, 127-133.

Ayers, R. S., Westcot, D. W. 1989. Water Quality for Agriculture. FAO Irr. and Drain. 29, 1-174, Rome.

Bernstein, L. 1970. Salt Tolerance of Plants. USDA. Agr. Inf. Washington, D. C. Bulletin No : 283, P. 3-23.

Düzgüneş, O., Kesici, T., Kavuncu, O. ve Gürbüz, F. 1987. Araştırma ve Deneme Metodları. 381 s., A. Ü. Ziraat Fakültesi Yayınları: 1021, Ders Kitabı: 295, Ankara.

Günay, A. 1984. Sebzecilik. Özel Sebze Yetiştiriciliği. 312 s. Çağ Matbaası, Ankara. (3), 293-304.

Howel, T. A., Hatfield, J. L., Rhoades, J. D. And Meron, M. 1984. Responce of Cotton Water Stress Indicators to Soil Salinity. Irrig. Sci. 5 (1), 25-36.

Kacar, B. 1972. Bitki ve Toprağın Kimyasal Analizleri:II. Bitki Analizleri. 646 s. A.Ü.Ziraat Fakültesi Yayınları: 453, Uygulama Kılavuzu: 155, Ankara.

Keck, T. J., Wagenet, R. J., Campbell, W. F. and Knighton, R. E. 1984. Effects of Water and Salt Stress on Growth and Acetylene Reduction in Alfalfa. Soil Sci. Soc. Am. J., 48 (6), 1310-1316.

Lal, R. K. 1985. Effect of Salinity Applied at Different Stages of Growth on Seed Yield and its Constituents in Field Peas. Indian J. of Agronomy. 30 (3), 296-299.

Maas, E. V., Hoffman, G. J. 1977. Crop Salt Tolerance Current Assesment, Jour. Irr. and Drain. Div. ASCE 103 IR2.

Mc William, J. R. 1986. The National and International Importance of Drought and Salinity Effects on Agricultural Production. Aust. J. Plant Physiol., 13, 1-13.

Oraman, M. N. 1968. Sebze İlmi. 256 s., A. Ü. Ziraat Fakültesi Yayınları: 323, Ders Kitabı No: 117, Ankara.

Vinten, A., Shalhevet, J., Meiri, A. And Peretz, J. 1986. Water and Leaching Requirements of Industrial Tomatoes Irrigated with Brackish Water. Irrig. Sci. 7 (1), 13-25.