Effects of Deficit Irrigation with Saline Water on Yield, Fruit Quality and Water Use Efficiency of Cantaloupe in an Arid Region

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ABSTRACT

High groundwater salinity, a high water table and secondary soil salinization are dominant conditions in eastern Isfahan Province, Iran. This region has a low annual rainfall, high annual evaporation demand, saline soils and limited fresh water supplies. To investigate the effects of irrigation deficit and salinity on cantaloupe (*Cucumis melo* L. var. *cantalupensis*) production, a field experiment was performed at the Salinity and Drainage Research Station of Rudasht, 65 km East of Isfahan. Irrigation treatments were T65, T80 and T95 (irrigation after 65, 80 and 95 percent of cumulative evaporation from Class A pan, respectively), each having three replicates. EC of irrigation water was 5.25 dS m^{-1}; irrigation water depth for the whole growing period was 300, 342 and 384 mm, for T65, T80 and T95 treatments, respectively. The results showed that T65 and T80 irrigation treatments significantly reduced fresh yield, number of fruit, fruit weight per plant and water use efficiency. Fresh-fruit yield was 31.73, 38.48 and 54.34 ton ha^{-1}, and water use efficiency was 10.58, 11.25 and 14.16 kg m^{-3} in T65, T80 and T95 irrigation treatments, respectively. A second order polynomial equation was fitted (R^2= 0.99) for production function (yield vs. irrigation water depth). The relationship between water use efficiency and irrigation water depth was also a second order polynomial equation (R^2= 0.97). Nitrogen and potassium content of fruits in T65 treatment was higher than T80 and T95 treatments. Effect of irrigation regimes was not significant on P and Na content of fruits, but was significant on Cl^- content (P< 0.05). Overall results showed that cantaloupe is a crop sensitive to soil moisture stress.

Keywords: Muskmelon, Production function, Trickle irrigation.

INTRODUCTION

The declining availability of fresh water has become a worldwide problem, which promotes the development of alternative, secondary quality water resources for agricultural use. Salinity can negatively impact plants through osmotic, nutritious, and toxic stresses. Growth and yield of most cultivated crops tend to decline when exposed to salinity (Maas and Hoffman, 1977). However, the response pattern of many crop species may substantially change due to environmental conditions (e.g., soil properties and weather) as well as by agricultural practices (e.g., irrigation methods) (Shannon and Grieve, 1999). Considerable yields were obtained using saline irrigation water (4–12 dS m^{-1}) in crops that had been previously defined as moderately sensitive to salt stress (Pasternak and De Malach, 1995; Bustan *et al.*, 2004).

Muskmelon (*Cucumis melo* L.), an important horticultural crop that is often

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[DOR: 20.1001.1.16807073.2009.11.4.5.0]

irrigated in semiarid or arid regions, has been examined under saline irrigation water (Shannon and Francois, 1978). In agreement with Maas and Hoffman's (1977) classification, most reports define melons as a moderately sensitive crop (salinity threshold of 1 dS m^{-1} and 8.4% yield decline per dS m^{-1}) (Mangal *et al.*, 1988; Maas and Grattan, 1999). Several research studies have been performed growing melons with saline water. These reports indicate that yields decline due to a significant reduction in fruit size, but salt stress caused an increase in parameters of fruit quality, such as total soluble sugars (Medlinger, 1994). However, safe and efficient use of saline water for irrigation requires proper management (such as trickle irrigation in deep sandy soils) to prevent development of excessive soil salinization for crop production (Wang *et al.*, 2007).

Brackish irrigation water strongly reduced vegetative growth and plant size in melons (Medlinger and Fossen, 1993), as compared to fresh-water grown plants. Bustan *et al.* (2005) tested the use of fresh irrigation water (1.2 dS m^{-1}) during the early vegetative phase and application of brackish water (7 dS m^{-1}) during the reproductive phase in melons. Indeed, the combination of fresh and brackish irrigation water increased the yield level to that of fresh water plants. Along side fruit quality improvement as typically seen in plants irrigated with brackish water, frequent daily regimes of trickle irrigation reduced the negative effect of salinity on fruit size.

There are different production functions which relate the amount of water applied to yield components. Water use efficiency (WUE) relates yield or dry mass production to applied water (Yuan *et al.*, 2003 and 2004). Fabeiro *et al.* (2002) used drip irrigation in controlled deficit irrigation of melons. Based on their study of 9 treatments including different water requirement levels (60 to 100 percent of reference crop evapotranspiration) at three growing stages (flowering, fruit setting and fruit maturity), they concluded that the best mathematical equation which fits yield and applied water is a second order polynomial (R^2= 0.95). The relationship between irrigation water and WUE was represented by a second order equation with R^2= 0.87.

Hossieni-Yazdi (1997) studied the effects of 50, 75 and 100 percent evaporation from Class A pan with drip and furrow irrigation methods on Charlston Gray watermelon. The results showed that WUE of the drip system was three times more than that for furrow irrigation.

Sensoy *et al.* (2007) studied the most suitable irrigation frequency and quantity for field-grown melon. Four different irrigation treatments employing two different irrigation intervals (6 and 12 days) and two plant-pan coefficients (0.60 and 0.90) were tested. Total irrigation quantities, plant water consumption and melon yields varied from 405 to 549 mm, 481–637 mm and 18.0–32.4 Mg ha^{-1}, respectively. The highest yield was obtained from the treatment employing the greatest frequency and quantity of irrigation.

Ertek *et al.* (2006) studied the most suitable irrigation frequency and quantity in cucumber grown under field conditions. Irrigation treatments consisted of two irrigation intervals (4 and 8 days), and three plant-pan coefficients (0.50, 0.75 and 1.00). Irrigation quantities applied to the treatments varied from 320 to 509 mm; seasonal evapotranspiration of irrigation treatments varied from 391 to 597 mm and the cucumber yield varied from 17.99 to 45.20 ton ha^{-1}. The highest yield was obtained from a 8-day irrigation interval and pan coefficient of 1.0

In an experiment by Tingwu *et al.* (2003), saline groundwater, ranging in salinity from 3.3 dS m^{-1} in the early season to 6.3 dS m^{-1} at the harvest time, was used in a drip irrigation system. Four irrigation treatments (control, 30, 60 and 90 percent of evaporation from a Chinese Evaporation Pan) were used. The control treatment was not irrigated throughout the season. The yield of watermelons was increased and the quality improved under drip irrigation, as

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compared with the control, with the highest increases in both yield and quality in the 60% treatment. The results suggested that drip irrigation of watermelon with saline water was feasible.

The purpose of this research was to investigate the effects of deficit irrigation using saline water from a drip system on cantaloupe production in Rudasht region, East of Isfahan, Iran.

MATERIALS AND METHODS

To investigate the effects of deficit irrigation and saline water (EC= 5.25 dS m^{-1}) on cantaloupe (*Cucumis melo* L. var. *cantalupensis*)'Garmak' production in Rudasht region, which is located about 65 km East of Isfahan, Iran. Mean annual temperature is 16.8°C, annual rainfall is < 100 mm, and annual evaporation demand is > 2000 mm. Based on De Martonne's classification, the climate in this region is arid. Because of intrinsic salinity and a high water table, soils are saline (EC of 50 to 200 dS m^{-1} in the uncultivated lands) and available fresh water supplies are very limited. Nevertheless, farmers manage to grow cantaloupe, watermelon, cotton and other salt-tolerant crops in this region and irrigation is therefore a requirement for crop production in this region. The soils are Aridisols and classified as Typic Salorthids, Fine Mixed and Thermic.

A trickle irrigation experiment with a complete randomized block design was selected. The irrigation treatments were T65, T80 and T95 (irrigation in each event applied 65, 80 and 95 percent of cumulative evaporation from Class A pan, respectively) in three replicates.

The experiments were conducted from 12 April to 22 July, 2003. Soil was ploughed and disked to the depth of 30 cm. The field was divided into 27 irrigation units. Each experimental plot was 6×5 m and the whole field was 22×53 m. Each unit consisted of six laterals, spaced 1 m apart; the units were spaced 2 m apart. Each lateral had 11 emitters, spaced 0.5 m apart. The emitters were long-path type with discharge of 4 L h^{-1} operating at the pressure of 1 atm.

Five cantaloupe seeds were planted next to each emitter. To ease germination and prevent crusting, the seeds were put in small holes filled with fine sand. After germination, the number of seedlings was reduced to two. After fruit setting, one fruit was kept for each plant so that there were two fruits next to each emitter.

Before the application of irrigation water treatments, to make sure that the seeds grow properly, 16 irrigation events (a total of 115 mm of water) were applied uniformly, until the 50th day (31 May, 2003). After that, 21 irrigation events were applied non-uniformly. There was no precipitation during the growing period. An irrigation interval was selected based on 30±3 mm cumulative evaporation from a Class A pan. The pan was located about 200 m from the experimental site.

The volume of irrigation water per plot was calculated as:

$$V_{iw} = E_{pan} \times K_{pan} \times S \times P \times A \times C \quad (1)$$

where V_{iw} is the volume of water per plot (liters); E_{pan} is cumulative evaporation from the pan (mm); K_{pan} is the pan coefficient; S is the canopy shading coefficient; P is the wetted-area coefficient (which is different from canopy shading coefficient); A is the area of each plot (30 m^2) and C is the irrigation coefficient (0.65, 0.8 and 0.95). Based on a wind speed of 2 m along with high, relative humidity and green fetch around the pan, the pan coefficient was calculated as 0.85 (FAO, 1998). The volume of irrigation water was measured using a flow-meter.

To calculate the canopy shading coefficient, it was assumed that each plant is a circle with an average diameter of d (in m) and, so, for later stage-irrigations (50 to 102 days after planting the seeds):

$$S = \frac{a \times n}{A} \quad (2)$$

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Table 1. Physical properties of the soil in the experimental site.

Depth (cm)	Soil particles (%) Clay	Silt	Sand	Soil texture	Bulk density ($g\ m^{-3}$)	Field capacity (%)	Permanent wilting Point (%)
0-30	32	37	31	Clay loam	1.47	30	14
30-60	37	44	19	Silty clay loam	1.46	27	14

Table 2. Chemical properties of the soil before running the experiments.

Depth (cm)	EC ($dS\ m^{-1}$)	pH	Cations ($meq\ L^{-1}$) Na	Ca + Mg	SAR	ESP
0-30	1.48[a]	7.49	8.53	7.11	4.52	5.11
30-60	1.71	7.49	9.9	8.45	4.87	5.6

[a] Each number is average of three replicates.

Table 3. Chemical properties of irrigation water.

EC ($dS\ m^{-1}$)	pH	Cations and Anions ($meq\ L^{-1}$) Na	Ca + Mg	CO_3^{-2}	HCO_3^-	Cl^-	SO_4^{-2}	SAR
5.25	7.52	41	17.72	0.49	4.53	35.78	16.92	13.1

$$a = \frac{\pi \times d^2}{4} \quad (3)$$

where a is the shading area of each plant and n is the number of plants per plot. Parameter d was measured in the field and averaged for each plot.

In dry regions, the wetted-area coefficient (P in equation 1) changes from 33 to 50 percent of the cultivated area. Therefore, some soil surface remains dry between the plants; this may save some water (Abu-Awwad, 2001). The wetted-area coefficient and canopy shading coefficient were increased as a result of plants growth during the growing season. On this basis, the wetted-area coefficient was considered as 33% in the early stage of irrigation treatments and as 50% at the later stages of growing season.

Fertilization (120 kg ha^{-1} urea at the first-stage irrigations and 60 kg ha^{-1} potassium sulfate at the start of applying the irrigation treatments) and pest control were performed uniformly for all treatments and based on local recommendations. Fruits were harvested on 15 to 23 July 2003, counted and weighed separately. From each plot, two cantaloupes were taken to a laboratory for measurements of their N, K, Na, P, Cl, EC, pH, total dry matter and total soluble materials.

Water use efficiency (WUE) was calculated by dividing fresh-fruit weight (kg) by the volume of irrigation water (m^3). The SPSS.11 software was used to analyze the data and the averages were compared by Duncan's multiple range test.

Some of the physical and chemical properties of the soil are presented in Tables 1 and 2. Soil samples were collected at the end of the experiment for EC measurement. Chemical properties of irrigation water are shown in Table 3. According to Wilcox' diagram, irrigation water is classified as

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C4S4. As it is seen from Table 2, the soil profile is not saline down to 60 cm.

RESULTS AND DISCUSSION

Applied Water and Cantaloupe Yield

In 37 irrigation events (from the beginning to the end of the experiments), a total of 300**,** 342 and 384 mm of water was applied in irrigation treatments T65, T80 and T95, respectively. Therefore, in irrigation treatments T65 and T80, about 22 and 11 percent water was saved, as compared with the irrigation treatment T95. Total evaporation from the pan was 283 mm from 31 May to 22 July 2003.

Analysis of variance and comparison of the averages of yield components are shown in Tables 4 and 5. Table 4 shows that the effect of total irrigation depth on fresh-fruit yield, yield per unit area and number of fruit; water use efficiency is significant at 1% probability level.

In irrigation treatments T65 and T80, yield reduction was 42 and 29 percent as compared to irrigation treatment T95. Fresh-fruit yield increased from 95 kg per plot in T65 to 163 kg per plot in T95 (Table 5). Although two fruits were kept next to each emitter in all the irrigation treatments, the number of fruit ranged from 21,667 (in T65 irrigation treatment) to 37,000 (in T95 irrigation treatment) at the end of the experiments. The reason for this reduction of fruit number was water stress that resulted from applying deficient irrigation. The cantaloupe plants could not get enough water to grow marketable fruits. This happened even in the T95 irrigation treatment. High salinity of irrigation water is another reason for low fruit number.

Most vegetables are rather shallow rooted, and stresses of even short periods of two to three days can hurt marketable yield. Irrigation is likely to increase size and weight of individual fruit (Sanders, 1997). According to Table 4, the effect of irrigation level on fruit weight per plant was significant ($P< 0.05$). Although there was no significant difference between fruit weight per plant in T65 and T80 irrigation treatments (Table 5), but they were different from T95 treatment ($P< 0.05$). This parameter was 1.47, 1.47, and 1.61 kg per plant, respectively. There was a linear relationship between the number of fruits and fruit yield ($R^2= 0.999$), which shows that yield increase is a function of both fresh-fruit weight and number of fruits:

$$FFW = 1.468FN + 95.18 \qquad (4)$$

where FFW= Fresh fruit weight (kg ha^{-1}) and FN= Number of fruits per hectare.

Cantaloupe yield was found to be 31.73, 38.48 and 54.34 ton ha^{-1} for T65, T80 and T95 irrigation treatments, respectively. The effect of amount of irrigation on yield was significant ($P< 0.01$) and differences between mean yields were significant at a 5% probability level (Tables 4 and 5). This relationship could be depicted as a second-order polynomial ($R^2 = 0.99$):

$$Y = 0.0026AW^2 - 1.496AW + 248.24 \qquad (5)$$

where Y= Yield (ton ha^{-1}) and AW= Applied saline irrigation water depth (mm).

Although previous studies (Kemble and Sanders, 2000; Maas and Grattan, 1999) have reported that threshold level of EC for cantaloupe production is about 1 dS m^{-1}, it is seen that we could obtain a yield of 31,735 kg ha^{-1} for the least irrigation treatment (T65) using an EC of 5.25 dS m^{-1}. This could be considered as a significant outcome of this study, which shows that tolerance of plants against salinity is not the same for different growing conditions.

Soil EC changed with the emitters' location outward and downward. For example, in the T80 irrigation treatment, EC changed from 3 to 15 dS m^{-1} (3 dS m^{-1} is for the soil sample under the emitters and 15 dS m^{-1} is for the surface soil sample 30 cm away from the emitters). The EC at the 60 cm depth below the emitters was about 4 dS m^{-1}. Similar results were obtained for the other two irrigation treatments. This observation shows that salts have moved

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Table 4. Analysis of variance of yield components and irrigation water use efficiency.

		Mean squares				
Source	df	Fresh-fruit yield (kg)	Yield per unit area (kg)	Number of fruit	Fruit weight per plant (kg)	Water use efficiency (kg m^{-3})
Irrigation treatment	2	10906.27**	1211.816**	3011.37**	0.05723*	32.554**
Replication	2	18.712	2.08	18.037	0.01136	0.147
Error	12	66.203	7.355	25.833	0.00845	0.618
F value		164.739	164.754	116.569	6.772	52.692
Probability level		0.0001	0.0001	0.0001	0.011	0.0001

*, ** : Significant at 5% and 1% probability level, respectively.

Table 5. Comparison of means of yield components and irrigation water use efficiency. [a]

Irrigation treatment	Amount of water applied (mm)	Fresh-fruit yield (kg per plot)	Yield (kg ha^{-1})	Number of fruit per ha	Fruit weight per plant (kg)	Water use efficiency (kg m^{-3})
T65	300	95.206 c	31735 c	21667 c	1.471 b	10.578 b
T80	342	115.453 b	38484 b	26000 b	1.473 b	11.253 b
T95	384	163.018 a	54339 a	37000 a	1.61 a	14.157 a

[a] Means followed by the same letter are not significantly different at 5% probability level, based on Duncan Multiple Range Test.

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Table 6. Analysis of variance of chemical components of fruits.

Source	df	Mean squares				
		N	K	P	Na	Cl
Irrigation treatment	2	0.00196**	0.00113**	776.694 ns	339.361 ns	14608.565*
Replication	2	0.00056	0.00144	4069	303.583	3118.287
Error	12	0.00027	0.00022	447.324	3163.144	2962.063
F value		4.930	0.107	1.736	6.772	52.692
Probability level		0.027	0.899	0.218	0.011	0.0001

*, **: significant at 5% and 1% probability levels, respectively.
ns: not significant

Table 7. Comparison of means of chemical components of fruits. [a]

Irrigation treatment	N (%)	K (%)	P (ppm)	Na (ppm)	Cl (ppm)
T65	0.13 a	0.25 a	94.39 a	437.78 a	627.5 b
T80	0.11 b	0.24 ab	79.83 a	431.89 a	624.17 b
T95	0.11 b	0.23 b	77.11 a	425.5 a	695.56 a

[a] Means followed by the same letter are not significantly different at 5% probability level based on Duncan Multiple Range Test.

away from the plants and gathered at the rim of the wetted areas. Proper soil management is needed at the beginning of the next growing season.

Irrigation Water Use Efficiency

Effect of irrigation depth on water use efficiency (WUE) was significant at a 1% probability level (Table 4). Irrigation treatments T65, T80 and T95 had WUE of 10.58, 11.25 and 14.14 kg m^{-3}, respectively; the increase in WUE could be related to yield. The average values of WUE in irrigation treatments T65 and T80 were not significantly different (Table 5). A second-order polynomial equation (R^2= 0.97) was found to relate WUE as a function of applied saline irrigation water:

$$WUE = 0.0006AW^2 - 0.3896AW + 70.59 \quad (6)$$

where WUE= Water use efficiency (kg m^{-3}) and AW= Applied irrigation water depth (mm). This relationship shows that cantaloupe is very sensitive to irrigation deficit. Similar results were obtained by Fabeiro *et al.* (2002) who worked on muskmelon.

Chemical Constituents of Fruits

The results of ANOVA and means for constituents and chemical parameters of the cantaloupe fruits are shown in Tables 6 to 9. The Effect of applied saline irrigation water on nitrogen content of fruits is significant at 1% (Table 6); the difference between the means of nitrogen content was also significant (Table 7). The mean nitrogen content of fruits was 0.13% for T65 and 0.11% for T80 and T95 irrigation treatments. Less leaching of fertilizers in T65 irrigation treatment is thought to be the reason for higher nitrogen values. If leached values of N and the N content in soil are measured, calculation of the N balance would be more precise. Measurement of N is important because (1) N serves as a constituent of proteins and nucleic acids, (2) nitrogen alters plant composition much more than any other mineral nutrient, and (3) an increase in the N supply delays senescence, stimulates growth, and changes plant morphology (Marschner, 1986).

The potassium content of fruits was 0.24, 0.23 and 0.25 percent, respectively, for irrigation treatments T65, T80 and T95 (Table 7). The difference between K values of T65 and T95 treatments was significant ($P< 0.05$). Since potassium is very stable in soil, lower potassium uptake in T65 irrigation treatment is thought to be the reason for higher K values as compared to the other two irrigation treatments. Potassium functions in osmoregulation, pH stabilization, protein synthesis, maintenance of electrochemical equilibria in cells, drought tolerance, and regulation of enzyme activities (Suelter, 1970; Wyn Jones *et al.*, 1979).

The effect of irrigation regimes was not significant on P and Na of the fruits, though small differences were observed between the treatments. Phosphorus serves as a constituent of proteins and nucleic acids (Marschner, 1986). The effect of irrigation regimes on chloride content of fruits was

Table 8. Comparison of means of EC, pH, TDM and TSM of fruits. [a]

Irrigation treatment	EC (dS m^{-1})	pH	TDM (%)	TSM (%)
T65	5.6 a	5.6 a	6.4 a	4.4 a
T80	5.42 ab	5.6 a	5.6 b	3.6 b
T95	5.23 b	5.5 b	5.4 b	3.0 c

[a] Means followed by the same letter are not significantly different at 5% probability level, based on Duncan Multiple Range Test.

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significant ($P< 0.05$). The average values of Cl^- were significantly different (Table 7); the Cl^- values were 627.5, 624.2 and 695.6 ppm for T65, T80 and T95 irrigation treatments.

Irrigation regimes had no significant effects on EC and pH of the fruits, but there were some differences between these treatments (Table 8). The EC of fruits decreased from 5.6 to 5.23 dS m^{-1} in T65 and T95 irrigation treatments, respectively. The pH decreased from 5.6 to 5.5 in T65 and T95 irrigation treatments, respectively. Total dry matter (TDM) percentage of the fruits was affected by irrigation regimes, and the mean values were different for irrigation treatments ($P< 0.05$). An increased applied irrigation depth decreased TDM from 6.4 to 5.4 percent of total fruit weight in T65 and T95 irrigation treatments, respectively (Table 8). The low TDM of the fruits is probably due to the local variety of the cantaloupe and salinity. Cantaloupe plants which received more saline irrigation water produced less TDM and were juicier.

Increasing applied irrigation water significantly decreased ($P< 0.05$) the total soluble materials (TSM) of the fruits (Table 8). This parameter, which is an indication of the fructose content of the fruits, was 4.42, 3.57 and 2.97 percent for the T65, T80 and T95 irrigation treatments, respectively. Therefore, sugar content of the cantaloupe fruits decreased by applying more irrigation water. Sanders (1997) also reported that irrigation reduces soluble solids in muskmelons and capsicin in hot peppers if applied during fruit development.

CONCLUSIONS

In an arid region East of Isfahan, Iran, cantaloupe yields were found to be directly related to deficit irrigation. Increasing applied saline irrigation water significantly increased yield components and irrigation water use efficiency. The fresh-fruit yield was reduced by irrigation deficit. Saline irrigation water depths of less than 95% of cumulative evaporation from a Class A pan is not recommended for production of cantaloupe in this arid region. Although melons are defined as moderately sensitive crops and the threshold value of salinity for them is 1 dS m^{-1}, these experiments showed that irrigation water salinity of 5.25 dS m^{-1} could be used for cantaloupe production in arid regions. Several research studies have been performed on growing melons with saline water. These reports indicate that melon yields decline due to a significant reduction in fruit size, but salt stress causes an increase in parameters of fruit quality, such as total soluble sugars. In the present experiments, a higher amount of applied saline irrigation water significantly decreased the total soluble materials of the fruits. However, safe and efficient use of saline water for irrigation requires appropriate practices to prevent development of excessive soil salinization for crop production. In this regard, many factors should be considered in making management strategies such as crops, crop cultivars, local climate, soil type, salinity levels, irrigation method, and water management practices.

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[DOR: 20.1001.1.16807073.2009.11.4.5.0]

تأثیر کم‌آبیاری با آب شور بر عملکرد، کیفیت میوه و راندمان مصرف آب گرمک در یک منطقه خشک

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چکیده

منطقه شرق استان اصفهان به شدت تحت تأثیر بالا بودن سطح ایستابی، شوری آب زیرزمینی و شور شدن ثانوی خاک قرار دارد. در این منطقه، میزان بارندگی سالانه بسیار کم، پتانسیل تبخیر سالانه زیاد، خاک منطقه شور و منابع آب مناسب بسیار محدود می‌باشد. برای بررسی تأثیر کم‌آبیاری و شوری بر محصول گرمک (*Cucumis melo* L.)، یک آزمایش مزرعه‌ای در مرکز تحقیقات شوری و زهکشی رودشت واقع در ۶۵ کیلومتری شرق اصفهان انجام شد. تیمارهای آبیاری شامل T65، T80 و T95 (آبیاری‌ها به ترتیب بعد از ۶۵، ۸۰ و ۹۵ درصد تبخیر تجمعی از تشت تبخیر کلاس A) بود و در سه تکرار انجام شد. شوری آب آبیاری ۵/۲۵ دسی‌زیمنس بر متر بود. عمق آب آبیاری برای کل فصل رویش به ترتیب ۳۰۰، ۳۴۲ و ۳۸۴ میلی‌متر برای تیمارهای T65، T80 و T95 اندازه‌گیری شد. نتایج نشان داد که تیمارهای T65 و T80 عملکرد میوه تازه، تعداد میوه، وزن میوه در بوته و راندمان مصرف آب را به طور معنی‌داری کاهش دادند. در تیمارهای T65، T80 و T95، عملکرد میوه تازه به ترتیب ۳۱/۷۳۵، ۳۸/۴۸۴ و ۵۴/۳۳۹ تن در هکتار و راندمان مصرف آب ۱۰/۵۸، ۱۱/۲۵ و ۱۴/۱۶ کیلوگرم بر متر مکعب به دست آمد. یک معادله چندجمله‌ای درجه دو (R^2 =۰/۹۹) برای تابع تولید (عملکرد نسبت به عمق آب آبیاری) برازش داده شد. رابطه بین راندمان مصرف آب و عمق آب آبیاری نیز یک چندجمله‌ای درجه دو (R^2 =۰/۹۷) بود. میزان نیتروژن و پتاسیم میوه در تیمار T65 بیشتر از تیمارهای T80 و T95 بود. تأثیر رژیم آبیاری بر فسفر و سدیم میوه معنی‌دار نبود اما بر میزان کلر معنی‌دار بود ($P< 0.05$). نتایج کلی نشان داد که گرمک به تنش خشکی حساس می‌باشد.

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