The Effects of Irrigation Regimes on the Yield and Water Use of Eggplant (*Solanum melongena* L.)

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ABSTRACT

The general objective of this study was to specify the influence of deficit irrigation on yield for eggplant grown under unheated greenhouse condition. The area trials were conducted at the Agricultural Research Station of Yenişehir Vocational School of Uludag University in Bursa, Turkey during growing season of 2007. In the study, irrigation regimes consisted of full irrigation (1.00 $K1_{cp}$) and three deficit irrigation treatments ($K2_{cp}$, $K3_{cp}$, and $K4_{cp}$ corresponding to 0.75, 0.50 and 0.25 of accumulative pan evaporation). A nonirrigated treatment ($K5_{cp}$) was also designed for control purpose. Applied irrigation water amounts were changed between 85 and 464 mm, and water consumption were varied from 170 to 472 mm. Eggplant yield, length, diameter, weight and dry matter were significantly influenced by irrigation water level. The highest yield averaging 62 t ha^{-1} was obtained at $K1_{cp}$. Crop yield response factor (k_y) for eggplant was found as 1.14. Water use efficiency (WUE) and irrigation water use efficiency (IWUE) for the $K2_{cp}$ treatment were calculated to be 13.16 and 10.63 kg m^{-3}. These were the highest WUE and IWUE values. $K2_{cp}$ application (75%) can be recommended as the most effective irrigation level for the eggplant to which drip irrigation is applied under scarce water resource and unheated greenhouse conditions.

Key words: Evapotranspiration, deficit irrigation, water use efficiency (WUE), yield and quality parameters, irrigation scheduling.

Sulama Rejimlerinin Patlıcanın (*Solanum melongena* L.) Verim ve Su Kullanımına Etkileri

Öz

Bu çalışmanın amacı, ısıtmasız sera koşulları altında patlıcan'ın verimi üzerinde kısıntılı sulamanın etkisini belirlemektir. Araştırma, 2007 yılında Bursa Uludağ Üniversitesi Yenişehir Meslek Yüksekokulu Tarımsal Araştırma İstasyonunda yürütülmüştür. Çalışmada, 2 günlük sulama sıklığına karşılık gelen A Sınıfı Buharlaşma Kabından olan buharlaşmanın 1.00 ($K1_{cp}$), 0.75 ($K2_{cp}$), 0.50 ($K3_{cp}$), 0.25 ($K4_{cp}$) ve 0.00 ($K5_{cp}$) % (kontrol olarak)'ı kadar patlıcana sulama suyu uygulanmıştır. Bitkiler için uygulanan sulama suyu miktarı 85 mm ile 464 mm ve bitki su tüketimi 170 mm ile 472 mm aralığında değişmiştir. Verim, boy, çap, ağırlık ve kuru madde miktarı üzerinde, sulama suyu düzeyinin etkisi önemli bulunmuştur. En yüksek verim 62 t ha^{-1} ($K1_{cp}$) olmuştur. Bitki verim tepki faktörü (k_y) 1.14 olarak bulunmuştur. Su kullanım randımanı (WUE) ve sulama suyu kullanım randımanı (IWUE) için en yüksek değerler, $K2_{cp}$ uygulaması için 13.16 ve 10.63 kg m^{-3} olarak bulunmuştur. Su kaynaklarının yetersiz olduğu ısıtmasız sera koşulları altında damla sulama ile sulanan patlıcan için $K2_{cp}$ uygulaması, en uygun su uygulama düzeyi olarak önerilebilir.

Anahtar Kelimeler: Evapotranspirasyon, su kullanım etkinliğ (WUE), verim ve kalite parametreleri, sulama planlaması.

INTRODUCTION

As a great advancement in agricultural production (Aldrich and Barto, 1999), greenhouse technology is the best possible way for efficient use of agricultural inputs under limited agricultural area and demand for vegetables. Environmental conditions are fully or partially controlled at greenhouses covered by transparent materials to obtain maximum yield and the highest quality. Greenhouse production is steadily increasing throughout the world (Enoch and Enoch, 1989; Von Elsner et al., 2000). Turkey takes fifth place in the world in terms of greenhouse covered land (FAO, 2013). Turkey has Mediterranean type greenhouses; low-priced, unheated plastic-covered frames with soil-grown crops. Recently, crop cultivation in greenhouses is being commercially realized at more than 50 countries (Mahajan and Singh, 2006).

Ritchie and Johnson (1990) stated that irrigation scheduling prevented soil water deficiency that was caused by falling below some lower limit values in a certain crop and soil condition, moreover, irrigation scheduling enabled estimations of the latest date for irrigation and effective irrigation to abstain from harmful influences of water stress on the crops. Insufficient irrigation decreases production as giving rise to water stress on the crops, on the other hand excessive irrigation reduces productivity. Therefore, drip irrigation system is very important in irrigation scheduling.

Approaches based on evapotranspiration (Bar-Yosef and Sagiv, 1982; Mc Neish et al., 1985; Clough et al., 1990; Hartz, 1993) or allowable soil-water depletion (Bogle et al., 1989) were mostly used to build some scheduling strategies for drip irrigation. Pan evaporation method which integrates evaporation measured from Class A pan to crop consumptive water use (CWU) is widely used method for estimating CWU. A pan coefficient (K_p) is used to relate these two quantities. An approach based on the pan coefficient (K_p) with no employment of complicated instrument may be considered as one of the simplest methods in irrigation scheduling. A certain estimation for k is generally compulsory in the view of regional and local characteristics, soil characteristics, plant physiology and cultural applications. Yuan et al. (2003) stated that k values that were estimated for regional irrigation scheduling program remained in low level for an effective irrigation management while it should be sufficiently high to eliminate water stress which might occur in urgent and special local conditions. There could be found many studies that focused on irrigation methods using Class A evaporation pan. Some of the studies are as follows; tomato (Locascio and Smajstrla, 1996), eggplant (Ertek et al., 2006), lettuce (Yazgan et al., 2008), green bean (Büyükcangaz et al., 2008), cucumber (Ayas and Demirtaş, 2009), pepper (Demirtaş and Ayas, 2009), onion (Ayas and Demirtaş, 2009), potato (Ayas and Korukçu, 2010; Ayas, 2013) and broccoli (Ayas et al., 2011).

Eggplant (Solanum melongena L.) is one of the conventional crops in many tropical, subtropical and Mediterranean countries. Although there have been many researches on the influences of regulated water limitation on yield and quality parameters, relatively few number of papers related eggplant irrigation under semi-arid conditions have mentioned the relationships among yield, vegetative growth, and physiological responses to different irrigation levels. However, some studies have been reported on eggplant irrigation in Turkey and other parts of the world (Behboudian, 1977; Graaf and Ende, 1981; Eliades, 1992; Chartzoulakis and Drosos, 1999; Ertek et al., 2002; Kırnak et al., 2002; Hamdy et al., 2002; Ertek et al., 2006;). These studies clearly exhibit that crop characteristics such as yield, fruit length, fruit weight and biomass production were highly connected with optimal amounts of irrigation water supply.

The goal of our trial was to specify the influences of different irrigation water levels on the yield, fruit diameter, length and weight and dry matter, daily and seasonal cumulative evaporation, yield response factor (k_y), water use efficiency (WUE) and irrigation water use efficiency (IWUE).

MATERIALS AND METHODS

Field trials were conducted under unheated greenhouse conditions in the region of Bursa-Yenişehir (40°15'09 "N latitude, 29° 38'43"E longitude and altitude of 225 m above mean sea level). For experimental purposes, high tunnel type plastic covered greenhouse with the size of 8 m x 40 m was built. The climate characteristics of the experiment field was hot and dry in summer and cold and rainy in winter. Total precipitation

Table 1. Some of chemical and physical properties of experimental field soil.
***Çizelge 1.*** *Deneme alanının bazı kimyasal ve fiziksel özellikleri*

Soil depth (cm)	Y (g cm⁻³)	Soil type	Field Capacity (%)	Wilting Point (%)	pH	Total Salt (%)	CaCO₃ (%)	Organic Matter	Available (kg da⁻¹)	
									P	K
0-30	1.34	SL	19.66	11.94	7.99	0.058	5.67	2.94	1.53	38.35
30-60	1.37	SL	17.26	9.98	8.04	0.051	8.49	1.39	1.24	19.52

Y:Unit weight of soil, SL:Sandy loam, P: Phosphorus, K: Potassium

of growth period and the average temperature of growth period for the regions where greenhouse experiments were carried out was 337.8 mm and 11.3 °C, respectively. The average minimum temperature was gauged as 3.6 °C in December while the maximum temperature was gauged as 23.3 °C in August (Anonymous, 2003). The soil of the experiment field was classified as sandy loam and soil pH ranged between 7.99 and 8.04. Some of the physical and chemical characteristics were presented in Table1.

Mankozeb and Endosulfan were sprayed to the experiment fields as a chemical drug against diseases and insect pests, and 120 kg ha⁻¹ 21% N and 120 kg ha⁻¹ 46 % P_2O_5 granular fertilizer was applied two weeks prior to sowing process. An additional 120 kg ha⁻¹ 46% K_2O fertilizer was applied when the crops reached to height of 15 cm. 10 L ha1- chlorophyllous-ethyl was sprayed against insects. Transplantation date of the eggplant seedlings to the plots was 5 September 2007. Eggplant seedlings came to the harvest stage after 114 days of the planting day. Eggplants were harvested once a week and it was harvested three times. In the experiments, row and plant spacing were 0.5 m 0.75 m, respectively. Each plot has contained 45 plants. 9 plants of middle row were harvested to prevent the water penetration from its neighboring plots (Figure 1).
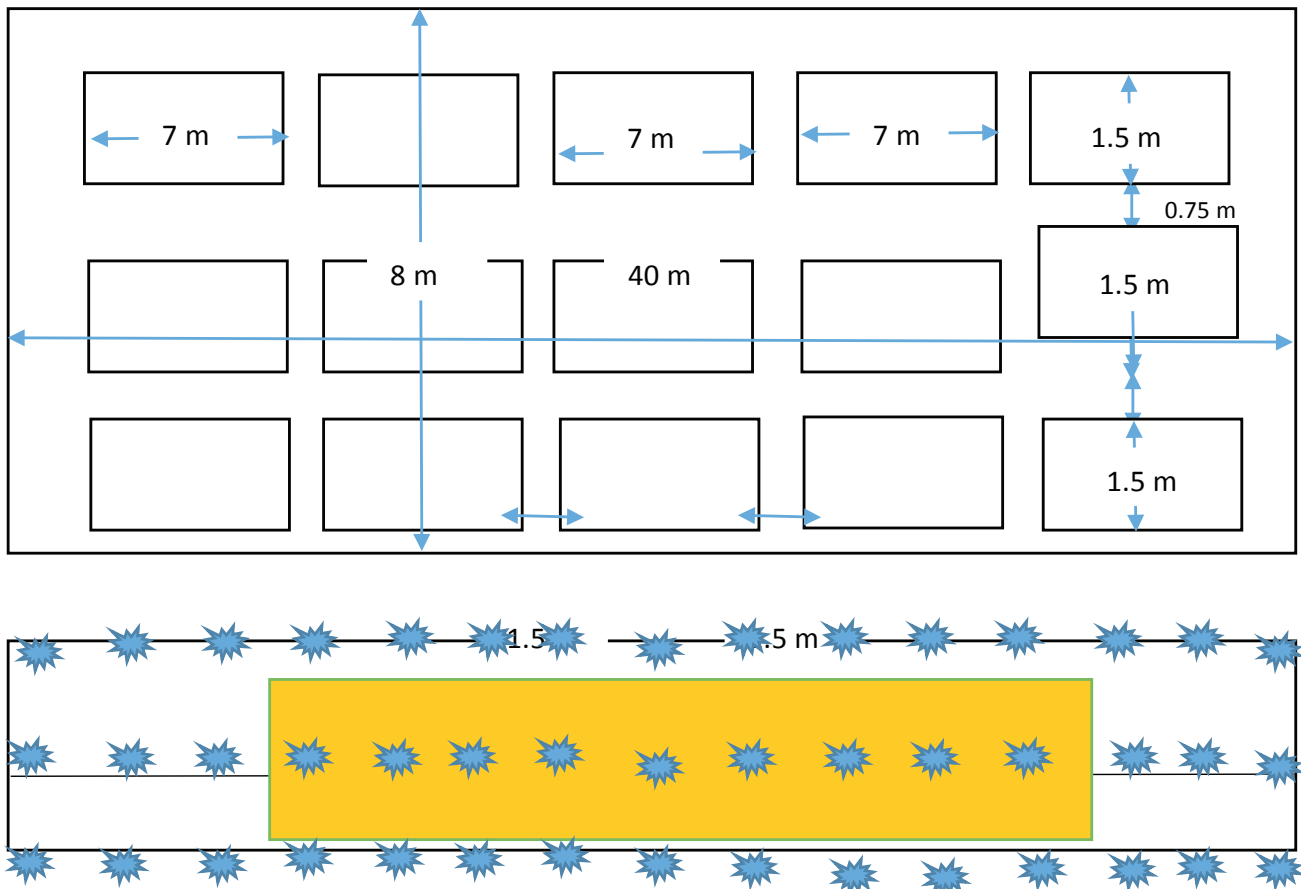
Figure 1. The order of the trial and details of parcels
Şekil 1. *Deneme düzeni ve parsellerin detayları*

The length (cm), diameter (cm) and weight (g) of eggplants were measured by callipers and the average of measured values was calculated. Dry matter content was determined by the separation and drying (at 65°C in drying oven) of fruits (two samples for each plot). . The amount of dry matter of fruits and leaves was determined by using Kjeldahl method (AOAC, 2000).The order of the trial was set as a randomized block design with 3-replication and single factor, and 5 irrigation applications were randomly distributed to each blocks. The irrigation applications were created using five different crop evaporation co-efficiencies (K1cp: 1.00, K2cp: 0.75, K3cp: 0.50, K4cp: 0.25, K5cp: 0.00-for control purposes). The amount of irrigation water was determined using below stated equation (Doorenbos and Pruitt, 1977; Kanber, 1984):

$$IW = E_{pan} \times K_{cp} \times P$$

Where, Ep is cumulative evaporation (mm) for 2-day irrigation frequency, Kcp is pan evaporation coefficient, and P is the percentage of wet area. Evaporations that occurred in the 2 day irrigation frequency was measured using US Weather Bureau Class A that was held in the center of greenhouse applications and drip irrigation method was used. The amount of irrigation water was measured with flowmeter devices at the gate of each plot. The required irrigation water was supplied from a deep well (3 L s-1) that was drilled in the field. Quality properties of the irrigation water were presented in Table-2. Irrigation water quality was low sodium risk and classified in C2S1 with medium level EC value.

Crop evapotranspiration (Cumulative evapotranspiration - ET_c) was calculated for 2 day irrigation interval using the below stated water balance equation;

$$ET_c=(SWC_{t0} - SWC_{t1}) + IW - D$$

Where $(SWC_{t0} - SWC_{t1})$ is the change in volumetric soil water content (mm); IW (mm) and D (mm) are, irrigation water depth (mm) and drainage (mm) for the related period, respectively.

Prior to irrigation water applications, water content in 0.60 mm soil depth was determined with a gravimetric method (Lorenz and Maynard, 1980). Water content of the soil was monitored till 0.90 depth with increments of 30 cm depth following irrigation applications for each irrigation application. In subplots, the percolations below 0.60 m soil depth were omitted. In our study, the relationships between yield and ET were determined by the Stewart model (Doorenbos and Kassam, 1979):

$$(1-Y_a / Y_m)= k_y (1-ET_a / ET_m)$$

Where, Ya and ETa are actual crop yield productivity (t ha^{-1}) and cumulative evaporation (mm), respectively, under insufficient irrigation conditions; Ym and ETm are maximum crop yield productivity (t ha^{-1}) and cumulative evaporation (mm) under sufficient water conditions. Yield productivity response factor of the limited irrigated eggplants was presented with ky. Water use efficiency (WUE) value was calculated to evaluate the irrigation efficiency in the applications. The two terms that are used to encourage the effective use of irrigation water in crop production phases are water use efficiency (WUE) and irrigation water use efficiency (IWUE). Water use efficiency (WUE) is calculated as the efficiency ratio of YLD to ETa and depicted as WUE = YLD / ETa (kg m^{-3}). Irrigation water use efficiency (IWUE) was estimated with the below stated equation (Howell et al., 1990):

$$IWUE(kg \ m^{-3}) = \frac{YLD-YLD_{rainfed}}{IRGA}$$

Where, YLD is yield value of each treatment plot (kg ha-1), YLD$_{rainfed}$ is yield value from control (full irrigated) treatment plot (kg ha-1), IRGA is seasonal irrigation water amount (mm). Eggplant seedlings completely grew and fruit had the yield productivity, fruit width, length and weight, color and taste characteristics to its species, 114 days (DOY=114) after plantation, i.e. in harvest season. Yield productivity and quality parameters, i.e. fruit width, length and weight and dry matter ratio, were evaluated for each harvest season.

Table 2. Chemical composition of irrigation water used in the experiment.
Çizelge 2. Denemede uygulanan sulama suyunun kimyasal bileşimi.

Water source	$EC_{25}x(10_6)$	Na$^+$	K$^+$	Ca^{++}	Mg^{++}	pH	Class	SAR
				(me L^{-1})				
Deep well	715	2.3	2.56	9.25	5.7	7.12	C2S1	0.85

Variance analysis was conducted with yield productivity and productivity components by using MSTAT-C (version 2.1-Michigan State University 1991) and MINITAB (Texas University, Austin) software. The significance of irrigation applications was calculated at 0.05 and 0.01 probability levels with F-test (Steel and Torrie, 1980).

RESULTS

Water applied and water used: All treatments received 85 mm irrigation water to refill available soil water content of 0-60 cm soil depth up to field capacity level following planting date. Class A pan measurements of evaporation were just started after first irrigation water application. The maximum and minimum amounts of irrigation water applied were 464 and 85 mm for $K1_{cp}$ treatment and $K5_{cp}$ treatment, respectively. The amount of water applied to other treatments varied from 116 to 348 mm. An increase in seasonal evapotranspiration (ET_a) was observed with an increase at applied irrigation water. The actual evapotranspiration ranged between 170 mm to 472 mm for $K5_{cp}$ and $K1_{cp}$ treatments, respectively (Table 3).
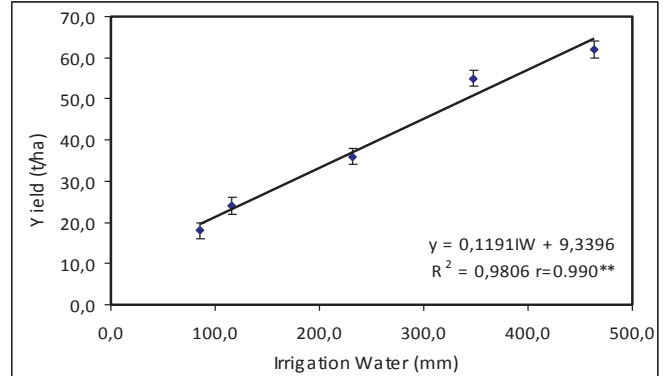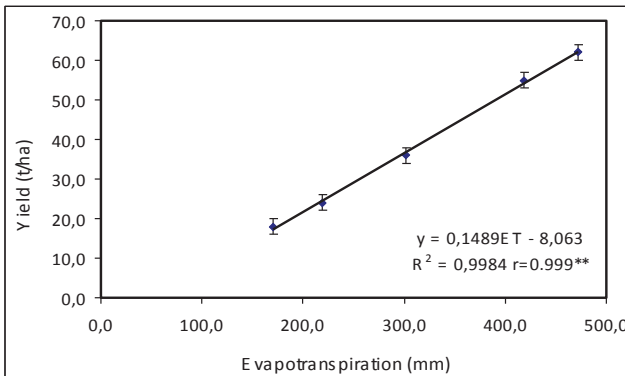
Linear relationships between crop evapotranspiration (ETc) with yield productivity (Ya), and irrigation water (IW) with yield (Y_a) were observed. The relationship equation is as follows; $Y_a = 0.1489ET_C - 8.063$ with $R^2 = 0.99$ and $Y_a = 0.1191$ IW $- 9.3396$ with $R^2 = 98$ (Figure 2).

The highest yield productivity was obtained from K1cp application with 62 t ha⁻¹. It was followed by K2cp, K3cp and K4cp applications, in order, with yield productivity values of 55 t ha⁻¹, 36 t ha⁻¹ and 24 t ha⁻¹, respectively. As expected, the minimum yield productivity (18 t ha⁻¹) was found from control $K5_{cp}$ application in which irrigation was not applied. The yield productivity of unirrigated $K5_{cp}$ application was lower at a rate of 244.4 % in a comparison with $K1_{cp}$ application. Moreover, lower yield productivity levels at a rate of 12.7 %, 72.2 % and 158.3 % from $K2_{cp}$, $K3_{cp}$ and $K4_{cp}$ applications were observed in a comparison with $K1_{cp}$ application, respectively (see Table 4).

Table 3. Relationship between the decrease in relative water use and decrease in relative yield and yield response factor for drip-irrigated eggplant.
***Çizelge 3.** Damla sulama ile sulanan patlıcan için oransal su kullanımındaki azalma ile oransal verim ve verim tepki faktöründeki azalma arasındaki ilişki.*

Irrigation treatment	Yield (t ha⁻¹)	Applied Water (mm)	ET_a (mm)	ET_a/ET_m	Y_a/Y_m	$1-(ET_a/ET_m)$	$1-(Y_a/Y_m)$	k_y
$K1_{cp}$	62	464	472	1.000	1.000	0.000	0.000	0.000
$K2_{cp}$	55	348	418	0.909	0.887	0.091	0.113	1.239
$K3_{cp}$	36	232	302	0.640	0.581	0.360	0.419	1.164
$K4_{cp}$	24	116	219	0.463	0.387	0.537	0.613	1.141
$K5_{cp}$	18	85	170	0.360	0.290	0.640	0.710	1.109

Figure 2. The relationship between crop evapotranspiration with yield and water irrigation with yield. (The errors bars are SE of 10 plants)
***Şekil 2.** Verim ile bitki su tüketimi ve verim ile sulama suyu arasındaki ilişki (Hata çubukları 10 bitkinin SE standart hata değeridir).*

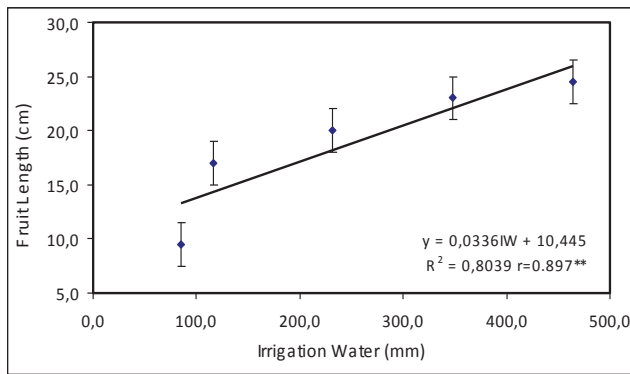**Table 4.** Effects of irrigation treatments on eggplant marketable parameters.
Çizelge 4. *Sulama uygulamalarının patlıcanın pazarlanabilir parametreleri üzerine etkisi.*

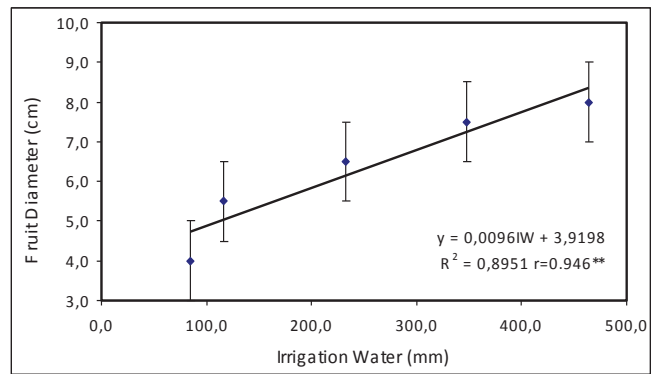| Irrigation treatment	Fruit length (cm)	Fruit diameter (cm)	Fruit weight (g)	Dry matter (%)	Yield (t ha⁻¹)
K1$_{CP}$	24.5a	8.0a	230a	8.0d	62a
K2$_{CP}$	23.0a	7.5a	222a	10.4c	55b
K3$_{CP}$	20.0a	6.5ab	202a	12.1bc	36c
K4$_{CP}$	17.0a	5.5ab	186ab	13.8ab	24d
K5$_{CP}$	9.5b	4.0c	144b	14.2a	18d
Treatments	**	**	**	**	**
Blocks	**	ns	ns	ns	ns

** Correlation is significant at the 0.01 level, * Correlation is significant at the 0.05 level, ns non-significant

Crop yields and quality are reduced due to water deficits applied particularly three or four weeks before harvest. Fruit length and fruit weight were significantly influenced by deficit irrigation, while the values of K1$_{cp}$, K2$_{cp}$, K3$_{cp}$, K4$_{cp}$ and K5$_{cp}$ treatments were each l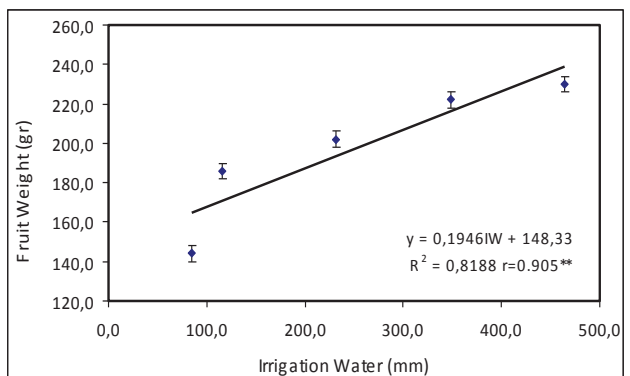ocated in a different statistical group. It may be concluded that significant reduction in fruit diameter was not observed with the deficit of applied irrigation water (25%). A high level of linear relationship was determined between fruit diameter, length and weight, whereas negative linear relation was found between dry matter and amount of water applied (IW). The related equations were
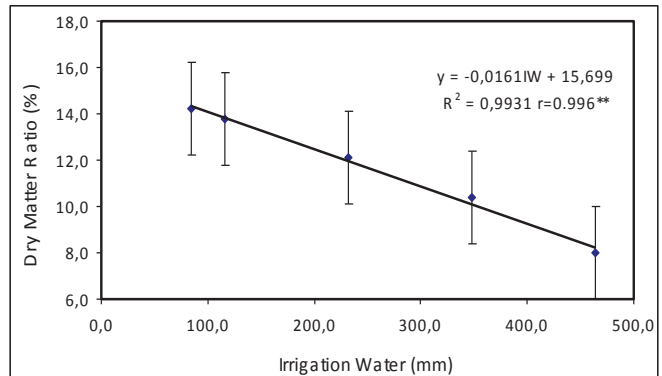
$y = 0{,}0336IW + 10{,}445$
$R^2 = 0{,}8039\ r=0.897**$

(a)

$y = 0{,}0096IW + 3{,}9198$
$R^2 = 0{,}8951\ r=0.946**$

(b)

$y = 0{,}1946IW + 148{,}33$
$R^2 = 0{,}8188\ r=0.905**$

(c)

$y = -0{,}0161IW + 15{,}699$
$R^2 = 0{,}9931\ r=0.996**$

(d)

Figure 3. Relationship between applied irrigation water and fruit length (a), diameter (b), weight (c) and dry matter (d). (The errors bars are SE of 10 plants)
Şekil 3. *Uygulanan sulama suyu ile meyve boyu (a), çapı (b), ağırlığı (c) ve kuru madde (d) arasındaki ilişki (Hata çubukları 10 bitkinin SE standart hata değeridir).*

as follows; fruit length = 0.0336IW + 10.445 with $R_2 = 0.80$ (Fig. 3.a), fruit diameter = 0.0096IW + 3.9198 with $R_2 = 0.90$ (Fig. 3.b.), fruit weight = 0.1946IW – 148.33 with $R_2 = 0.82$ (Fig. 3.c.), and dry matter = -0.0161IW + 15.699 with $R_2 = 0.99$ (Fig. 3.d.).

Crop yield response factor (k_y): Linear relationship between proportional decrease in water consumption and proportional decrease in yield productivity is depicted with crop yield productivity response factor (k_y) that represents yield productivity response to be lowered in water consumption. In other saying, it explains the decrease in yield productivity in relation with the decrease in water consumption per unit (Stewart et al., 1975; Doorenbos and Kassam, 1979). For irrigation application, seasonal yield productivity response factor (k_y) was calculated as 1.14 (see Fig. 4). k_y values increased with parallel to increase in water amount, except K5$_{cp}$ application.
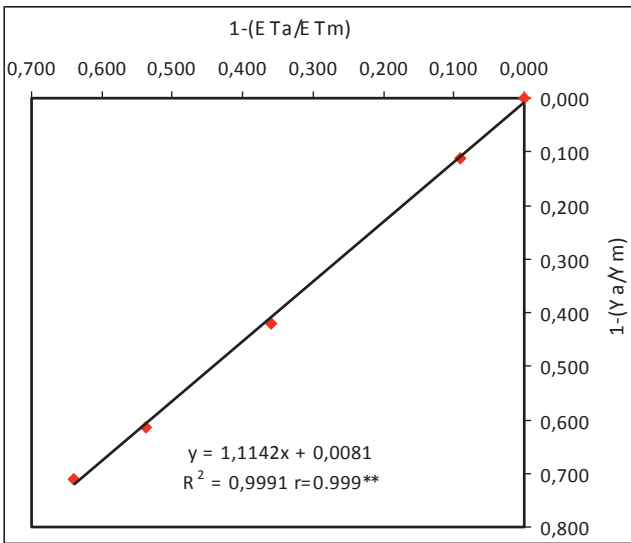
Figure 4. Relationship between relative yield decrease and relative crop evapotranspiration decrease for eggplant throughout the total growing season

Şekil 4. *Toplam büyüme mevsimi boyunca patlıcanda oransal bitki su tüketimindeki azalma ile oransal verimdeki azalma arasındaki ilişki.*

Water use efficiencies: Values of WUE and IWUE was lowered when the amount of irrigation water was reduced. The highest WUE and IWUE values were calculated from K2cp application as 13.16 and 10.63 kg m^{-3}, respectively. IWUE value of K2cp application was found higher than other applications as K1cp, K3cp, K4cp and K5cp, in order (See Table 5).

Table 5. Total water use efficiency (WUE) and irrigation water use efficiency (IWUE) values for drip- irrigated eggplant at different irrigation treatments.

Çizelge 5. *Farklı sulama uygulamalarında damla sulama ile sulanan patlıcan için toplam su kullanım randımanı (WUE) ve sulama suyu kullanım randımanı değerleri.*

Irrigation treatment	Yield t ha^{-1}	WUE kg m^{-3}	IWUE kg m^{-3}
K1$_{cp}$	62	13.14	9.48
K2$_{cp}$	55	13.16	10.63
K3$_{cp}$	36	11.92	7.76
K4$_{cp}$	24	10.98	5.17
K5$_{cp}$	18	10.59	0.00

DISCUSSION

Chartzoulakis and Drosos (1999) reported that the water requirements of eggplant ranged between 150 mm and 380 mm. Eliades (1992) stated that the eggplant could grow with as low as 285 mm of water. Aujla et al. (2007) stated that required irrigation water amount of eggplant ranged between 618 and 1051 mm, the seasonal evapotranspiration was between 815 and 1222 mm. When irrigation water was applied to eggplant at the 10 mm of pan evaporation, the highest evapotranspiration (800 mm) was observed in a study of (Chiaranda and Zerbi, 1986). Ertek et al. (2006) also found that applied irrigation water amounts for each treatment ranged from 372 to 689 mm, while average evapotranspiration values changed between 420 and 689 mm. Irrigation water (1276 mm) was applied to full irrigation (100 % refill of A pan evaporation) treatment of drip-irrigated eggplant in Southeastern part of Turkey, and the seasonal water amount for eggplant changed between 905 and 1373 mm in the same study (Kırnak et al., 2002). In their study for eggplant production in soilless culture, the average water consumption of eggplant was found as low as 290 mm under Mediterranean climate conditions (Hamdy et al., 2002). Seasonal crop water consumption for eggplant yield ranged from 452 mm – 696 mm (Ertek et al., 2002). In our study, irrigation water applied to eggplants changed between 85 and 464 mm, and water consumption changed between 170 to 472 mm for eggplants. These results are notably in accordance with the irrigation water amounts and crop water consumption values obtained from previous studies (Eliades, 1992; Chartzoulakis and Drosos, 1999; Ertek et al., 2006).

The eggplant yield changed between 18 t ha^{-1} and 62 t ha^{-1}. Based on to the results of this study, a significant effect of deficit irrigation was observed on fruit yield. This result is in agreement with those of (Chartzoulakis and Drosos, 1999; Ertek at al., 2002; Ertek et al., 2006; Aujla et al., 2007; Lovelli et al., 2007; Ünlükara et al., 2008). Previous researches have presented similar results under different irrigation regimes (Ertek et al., 2006; Aujla et al., 2007; Michalojc and Buczkowska, 2009). Yield was considerably lowered as the amount of irrigation water reduced. Quality parameters such as fruit diameter, length and weight have produced a similar response to deficit irrigation as observed at yield. As expected, all irrigation treatments had higher values than the non-watered (K5cp) treatment. These values are similar to those of (Kara et al., 1996; Ertek et al., 2006; Lovelli et al., 2007; Karam et al., 2009; Şenyiğit et al., 2011). Since K1cp treatment has higher fruit weight than the other treatments, the lowest dry matter was found at K1$_{cp}$ treatment when the highest was observed at K5$_{cp}$ treatment. We may conclude that significant increases in dry matter may be experienced by the increasing level of irrigation water deficit. These results are in agreement with those of (Ertek et al., 2006; Lovelli et al., 2007; Aujla et al., 2007).

WUE and IWUE values varied from 10.59 to 13.16 and from 0.00 to 10.63, respectively. K2$_{cp}$ treatment has delivered the highest WUE and IWUE with 13.16 and 10.63 kg m^{-3}, respectively. When the results regarding water use efficiency are compared with the findings of different researchers, they were found to be similar (Kara et al., 1996; Ertek et al., 2002; Lovelli et al., 2007; Dutta and Tafardar, 2008). Eggplant variety choice, climate, soil structure and effective use of water also affect these values. Crop yield response factor (k$_y$) was calculated as 1.14. The specified value of k$_y$ (1.14) which is greater than 1.00 shows that eggplant is susceptible to the water. Crop yield response factor (k$_y$) also coincides with the values found by researchers who studied on similar issues (Kara et al., 1996; Lovelli et al., 2007; Dutta and Tafardar, 2008; Karam et al., 2009).

CONCLUSIONS

The ultimate goals of optimum irrigation management strategies in deficit areas are to enhance yield and quality as much as possible, increase WUE and reduce water consumption. K2$_{cp}$ treatment allowed high yield and quality (in terms of fruit length, diameter and weight), increased WUE and reduced water use. The variety choice of eggplant, climate and soil structure also influenced to change WUE and IWUE values. Crop yield response factor of eggplant (1.14) which is greater than 1.00 shows that eggplant is susceptible to the water. K2$_{cp}$ application (75%) can be recommended as the most effective irrigation level for the eggplants to which drip irrigation is applied under scarce water resource and unheated greenhouse conditions.

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