Scientific Papers. Series B, Horticulture. Vol. LIX, 2015
Print ISSN 2285-5653, CD-ROM ISSN 2285-5661, Online ISSN 2286-1580, ISSN-L 2285-5653

EFFECTS OF DIFFERENT IRRIGATION TREATMENTS ON QUALITY PARAMETERS OF CUT CHRYSANTHEMUM

Arif TURAN[1], Yusuf UCAR[1], Soner KAZAZ[2]

[1]Süleyman Demirel University, Agricultural Faculty, Farm Structure and Irrigation Department, 32260, Isparta-Turkey, Phone: +90 246 2118565, Fax: +90 246 2118696, Email: arifturan43@gmail.com. yusufucar@sdu.edu.tr
[2]Ankara University, Agricultural Faculty, Horticulture Department, 06100, Dışkapı-Ankara-Turkey. Tel: +90 312 5961287, Fax: +90 312 317 67 24, Email: skazaz@ankara.edu.tr

Corresponding author email: yusufucar@sdu.edu.tr

Abstract

This study was carried out to determine the effects of different irrigation intervals and water amounts on yield and quality parameters of cut chrysanthemum. Spray cut chrysanthemum (cv. 'Bacardi') plant was used as a plant material. Class A pan was placed in the greenhouse to determine the amount of irrigation water values. Irrigation treatments consisted of three irrigation intervals (I_1: 2-, I_2: 4-, and I_3: 6-day) and four crop-pan coefficients (k_{cp1}: 1.20=T_1, k_{cp2}: 0.90=T_2, k_{cp3}: 0.60=T_3, and k_{cp4}: 0.30=T_4). The irrigation water amounts applied to the experimental treatments ranged from 249.7 to 517.9 mm, and seasonal evapotranspiration ranged from 340.9 to 560.5 mm. Different irrigation water amounts and irrigation intervals had statistically significant effects on flower stem length, stem diameter, stem weight, the number of flowers, the vase life and root length of chrysanthemum. Stem length varied between 52.36-79.81 cm, stem diameter varied between 4.62-7.69 mm, stem weight varied between 32.48-123.61 g and root length varied between 18.88-24.22 cm. The optimum irrigation scheduling was T_1I_1, in which the longest flower stem and the highest stem weight were obtained.

***Key words**: Chrysanthemum, Class A Pan, Evapotranspiration, Irrigation interval, Water deficit.*

INTRODUCTION

The total production area of ornamental plants worldwide is 1.573.167 ha according to the data of 2013. Some 651.800 ha of it is composed of cut flowers and pot plants. The important production regions according to land areas are Asia, North America, Europe, South America, Africa, and the Middle East. The continent with the largest production area for cut flowers and pot plants worldwide is Asia-Pacific (468.000 ha) (Anonymous, 2013). Chrysanthemum is one of the major cut flowers in the world. The demand for the flower reached 35% of the overall market request, second only to roses (Steen, 2010).

As in all plants, irrigation is an essential practice for chrysanthemum growing, but its adequate handling has been neglected by growers, resulting in growing loss and consequent productivity and quality decreases in the final product (Farias et al., 2009). In order to irrigate more extensive areas with the available water resources, such factors as soil, plant, and water resource must be taken into consideration. In addition, the values of plant water consumption under either sufficient or deficient water conditions should be known throughout the growing season of plants and water-yield relationships should be formed accordingly. These data can be obtained by making a large number of investigations for each plant (Doorenbos and Kassam, 1979). To generate the data concerned, Conover (1969), Harbaugh et al. (1985), Parnell (1989), Kiehl et al. (1992), Schuch et al. (1998), Rego et al. (2004), Conte e Castro et al. (2005), Fernandes et al. (2006), Budiarto et al. (2007), Farisa et al. (2009), Waterland et al. (2010) and Villalabos (2014) made investigations on irrigation and flower quality in the chrysanthemum plant. The majority of the investigations concerned are in the form of pot studies, and they are studies in which the plant quality was determined in different soil moisture tensions. Unlike the above-mentioned studies, this study aimed to determine the effects of different irrigation intervals and water amounts on yield and quality parameters in the chrysanthemum plant under greenhouse conditions in the Mediterranean climatic zone.

MATERIALS AND METHODS

The research was conducted in a polyethylene-covered greenhouse of 255 (6 m x 42.5 m) m^2 on the Research and Application Farm of the Faculty of Agriculture at Süleyman Demirel University (lat. 37.83° N, long. 30.53° E, altitude 1,020 m) in 2011 (in Isparta, Turkey). Some characteristics of the greenhouse soil (in 0- to 50-cm depths) were as follows: texture: clay loam; bulk density: 1.32-1.41 g cm^{-3}; field capacity: 24.80-27.01%; permanent wilting point: 7.08-8.51%, and total available water holding capacity in 0- to 50-cm soil depths: 123.6 mm (Table 1).

Table 1. Some Properties of the Soil in the Greenhouse Soil

Soil Depth	FC		WP		BD	AWHC	
cm	%	mm	%	mm	g cm^{-3}	%	mm
0-25	24.80	81.8	7.08	23.4	1.32	17.7	58.4
25-50	27.01	95.2	8.51	30.0	1.41	18.5	65.2
Total		177.0		53.4			123.6

FC: Field capacity, WP: Wilting pointh, BD: Bulk Density, AWHC: Available water holding capacity.

The mean daily temperature ranged from 20 to 30°C in the greenhouse but from 15 to 25°C outside the greenhouse in 2011. The relative humidity was 70-80% in the greenhouse but 50-70% outside the greenhouse (Figure 1) (DMI, 2011). Spray cut chrysanthemum (*Chrysanthemum morifolium* cv. 'Bacardi') was used as the plant material in the research. Uniform rooted cuttings were planted on 20 June 2011 into plots (1-m length, 1-m width) with five rows (20×12.5 cm spacing, 40 plants/m^2), and each plot contained 40 plants. Plants were grown under long day (LD) conditions until the plant height reached 0.3 m, followed by short day (SD) period up to harvesting. SD (08:00-17:00) period was enforced by using a blackout screen (Kofranek, 1980; Kazaz et al., 2010; Lin et al., 2011). Fertilization was applied to each treatment at equal amounts as follows: (ppm): N: 200, P: 20, K: 150, Ca: 80, Mg: 25, Fe: 3.0, Mn: 0.5, Cu: 0.02, Zn: 0.05, B: 0.5, Mo: 0.01 (Yoon et al 2000). Standard cultivation practices for flower bud removal, supporting system, disease and pest control as used for commercial standart spray cut chrysanthemum production in Turkey were employed for growing the crops during the experiment. The practice of pinching was not applied to the plants in the study.

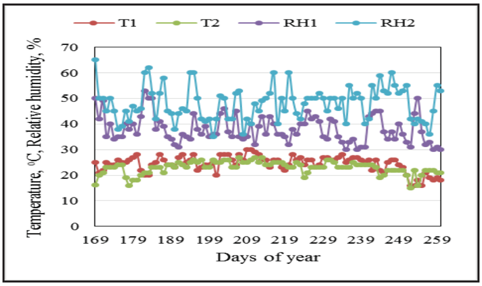

Figure 1. Temperature and relative humidity values at inside and outside of greenhouse. (T_1 and RH_1: Temperature and relative humidity at inside of greenhouse, T_2 and RH_2: Temperature and relative humidity at outside of greenhouse)

All the water which evaporated from Class A Pan (CAP) for 25 days after planting (DAP) was applied equally to all the treatments as irrigation water to ensure the root development and full survival of seedlings. The application of different irrigation intervals and irrigation water amounts was initiated 25 days after planting (DAP). The irrigation treatments were arranged as three different irrigation intervals (I_1:2-, I_2:4-, and I_3:6-day) and 4 different crop-pan coefficients (T_1:k_{cp}1=1.20, T_2:k_{cp}2=0.90, T_3:k_{cp}3=0.60, and T_4:k_{cp}4=0.30). The experiment was conducted according to the randomized plots experimental design with 3 replications.

The CAP placed in the greenhouse was utilized to determine the irrigation water amounts (Allen et al., 1998). Irrigation treatments were based on the evaporation data (Ep, mm) obtained from a CAP located inside the greenhouse. Irrigation water amount was calculated using Equation 1. Irrigation water was applied to each irrigation treatment by measuring it with a water meter.

$$IW = A \times E_{pan} \times k_{cp} \quad [1]$$

In the equation, IW denotes the irrigation water (mm), A the plot area (m^2), E_{pan} the amount of cumulative evaporation at the irrigation interval (mm), and k_{cp} the crop-pan coefficient.

The irrigation applications were carried out with the drip irrigation method. The dripper and lateral space was 20 cm, whereas the dripper discharge was 2 l/h (Uçar et al., 2011). The soil water content in the root zone of the plant was measured by means of watermarks (Irrometer, Model; Watermark200SS, USA). The watermarks were placed in the depths of 15 and 40 cm from the soil surface, with each experimental plot containing 2 watermarks. The watermarks were calibrated, and the calibration equation was found as $Pw=48.626\times kPa^{-0.302}$ ($R^2=0.97$) (Pw: Soil moisture as the percentage of dry weight; kPa: Watermark readings).

Plant water consumption was computed by using Equation 2 according to the fundamental principle of water budget by considering the soil moisture values measured before each irrigation application (Allen et al., 1998):

$$ET = I + P - RO - DP + CR \pm \Delta SF \pm \Delta SW \quad [2]$$

In the equation, ET denotes plant water consumption (mm), I the irrigation water applied (mm), P precipitation (mm), RO surface runoff (mm), DP deep percolation (mm), CR capillary rise (mm), ΔSF subsurface runoff (mm), and ΔSW the change in the moisture content of the root zone (mm). Precipitation (P), surface runoff (RO), capillary rise (CR) and subsurface runoff (ΔSF) were neglected in the calculations. The chrysanthemum plant is shallow-rooted, and its effective root depth is about 30 cm. Thus, the values of the watermark placed at the 15th cm were taken into consideration in the computations of plant water consumption, while the deep percolations were examined from the watermark at the 40th cm in depth. The moisture values above the field capacity in the root zone of the plant were considered deep percolation. When the watermark reading limit was exceeded (199 kPa), soil samples were collected from the experimental treatments and the soil moisture content was determined with the gravimetric method.

The flowers were harvested on September 15, 2011, when the flower in the middle opened completely and the surrounding flowers displayed full development. Stem length, stem diameter, stem weight, the number of flowers, vase life and root length were determined.

The obtained data were subjected to an analysis of variance by means of MINITAB 16 computer software, and the LSD Multiple Comparison test was applied by means of MSTAT-C computer software in order to compare the averages.

RESULTS AND DISCUSSIONS

Irrigation Water and Evapotranspiration: The values of irrigation water, percolated water, and plant water consumption applied according to the experimental treatments are provided in Table 2. All the water which evaporated from CAP for 25 DAP (160.3 mm) was applied to all treatments as irrigation water to ensure the root development and full survival of seedlings. During the growing period, 517.9, 428.5, 339.1 and 249.7 mm of water was applied to treatments T_1, T_2, T_3, and T_4, respectively. The total amount of evaporation was 458.3 mm (Table 2).

Table 2. Evaporation and irrigation water values in the treatments

Treatments	Evaporation (from CAP)	IW_1	IW_2	IW
T_1		160.3	357.6	517.9
T_2	458.3*	160.3	268.2	428.5
T_3		160.3	178.8	339.1
T_4		160.3	89.4	249.7

*: 160.3 mm of evaporation had been measured before making a transition to scheduled irrigation. IW_1: The irrigation water amount applied to the experimental treatments before making a transition to scheduled irrigation (mm), IW_2: The irrigation water amount applied according to the k_{cp} coefficients after making a transition to scheduled irrigation (mm); IW: Total irrigation water (mm).

The values of evapotranspiration measured according to the experimental treatments are presented in Figure 2. The highest evapotranspiration took place in T_1 treatments, where 1.2 times the water which evaporated from the evaporation pan was applied as the irrigation water (I_1T_1: 560.5 mm, I_3T_1: 553.4 mm, and I_2T_1: 552.7 mm), followed by T_2 (I_1T_2: 504.6 mm, I_2T_2: 491.3 mm, and I_3T_2: 486.7 mm), T_3 (I_1T_3: 427.4 mm, I_2T_3: 423.1 mm, and I_3T_3: 415.2 mm), and T_4 (I_1T_4: 345.7 mm, I_2T_4: 342.5 mm, and I_3T_4: 340.9 mm). In the study, it is seen that the evapotranspiration varied at different irrigation intervals even if the same amount of irrigation water was applied. Since the soil surfaces of the treatments with short irrigation intervals were continuously wet, the values of plant water consumption measured in these treatments were higher. The deep percolation values ranged from 27.72 to 18.90 mm according to the experimental treatments. Since the irrigation water amount applied at the beginning of the experiment was higher than the values of plant water consumption, the majority of deep percolation (18.90 mm) had taken place before making a transition to scheduled irrigation. After making a transition to scheduled irrigation, no deep percolation occurred in treatments T_3 and T_4 (Figure 2).

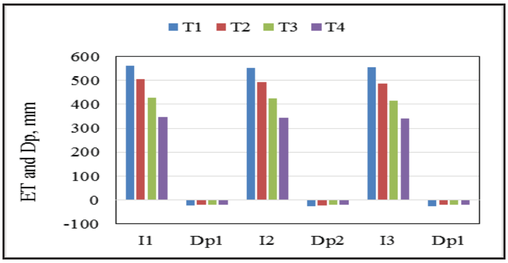

Figure 2. Evapotranspiration and deep percolation values according to the experimental treatments (T_1, T_2, T_3 and T_4: The level of irrigation water amount; I_1, I_2 and I_3: Irrigation interval; Dp_1, Dp_2 and Dp_3: Deep percolation; ET: Evapotranspiration)

Quality Parameters: Different irrigation intervals and irrigation water amounts significantly affected stem length, stem diameter, number of flower, stem weight, and root length at %1 level, and affected vase life at %5 level (Table 3).

Stem length: Growing conditions (temperature, light, photoperiod, relative humidity, CO_2, and planting density) have significant effects on plant height, the number of flowers per plant, and flower size that are among the important quality criteria in chrysanthemum (Carvalho & Heuvelink, 2001). The main climatic factor used to control plant height is temperature (Carvalho et al., 2002), and the optimum temperature requirement of chrysanthemum is 18-20^{o}C (van der Ploeg & Heuvelink, 2006). In this study, however, the temperature of the interior of the greenhouse ranged from 20 to 30^{o}C.

The increased irrigation water amount caused significant increases in stem length. The longest stem (75.03 cm on average) was recorded in T_1 treatments, to which the largest amount of irrigation water was applied, followed by T_2 (70.99 cm), T_3 (65.21 cm), and T_4 (57.22 cm) with the smallest amount of irrigation water application. The highest stem length in T_1 with the largest amount of irrigation water application was obtained from I_1 (79.81 cm). Stem lengths were 73.75 and 71.52 cm in I_3 and I_2, respectively (Table 4). The differences between I_1 and I_2 and between I_1 and I_3 were statistically significant, while the difference between I_2 and I_3 was insignificant. Likewise, the longest stem in T_3 treatments was determined in I_2 (67.93 cm), followed by I_1 (67.18 cm) and I_3 (60.52 cm). Although there was a difference between I_1 and I_2, it was not statistically significant. In T_2 and T_3, the highest stem length was obtained from I_1. When the same amount of water was applied at different irrigation intervals, its effect on stem length was not the same. This led to an interaction between the irrigation intervals and irrigation amount. The longest stem (70.96 cm) was recorded in I_1 with a 2-day irrigation interval, followed by I_2 (67.44 cm) and I_3 (62.94 cm). It was also stressed by Harbaugh et al. (1985) that stem length generally increased with an increase in the irrigation water amount applied. In the study concerned, they stated that the plant height was 62 cm in the treatment of 0.16 cm/day, 76 cm in the treatment of 0.24 cm/day, 86 cm in the treatment of 0.31 cm/day, 92 cm in the treatment of 0.40 cm/day, and 97 cm in the treatment of 0.47 cm/day. These data are in agreement with our results. Stem length is one of the most important indicators for the market value in chrysanthemum, as in the other cut flower species. Although varying by country, the branches which are 70-80 cm long are generally preferred in chrysanthemum (Kazaz, 2010). Chrysanthemums are classified when their flower stem lengths are 60-75 cm according to the classification in the USA but when their flower stem lengths are 50-70 cm according to the classification in England (Mengüç, 1996). All experimental treatments according to the English classification and all treatments other than I_2T_4 and I_3T_4 according to the American classification are included in the good class.

Table 3. The results of variance analysis of mean values of spray cut chrysanthemum quality parameters

Variation Sources	Mean square error						
	df	Stem length	Stem diameter	Stem weight	Number of flower per plant	Vase life	Root length
Replication (R)	2	19.45	0.16	74.70	6.02	5.86	0.10
Irrigation Interval (II)	2	194.22**	4.31	552.40**	54.28**	12.19*	2.96**
Irrigation water amount (IW)	3	537.44**	5.37**	8211.40**	440.99**	10.74*	38.09**
II*IW	6	22.60**	0.13**	191.80*	13.43**	4.05**	0.26
Error	22	6.03	0.12	60.0	4.00	1.89	0.41
Total	35	2307.86	28.49	28358.90	1612.22	106.22	130.97

df: degrees of freedom,*$P<0.05$ and **$P<0.01$

Stem weight: Stem weight ranks first among the most important quality criteria which are taken as the basis in the marketing of chrysanthemums worldwide. At the flower auction of the Netherlands (FloraHolland), the stem weights range from 45 to 105 g depending on the stem length (65, 70, and 72 cm) in spray chrysanthemums. In addition, the optimal stem weight is 70 g (Anonymous, 2010).

In terms of the irrigation water amounts, the highest stem weight was found in T_1 (108.72 g on average), followed by T_2 (83.79 g on average), T_3 (60.09 g on average), and T_4 (38.67 g on average). In terms of the irrigation intervals, the highest stem weight was obtained from I_1 (78.89 g on average), followed by I_2 (74.07 g on average) and I_3 (65.49 g on average). I_1 and I_2 were not statistically different in either T_1 or T_2, ranking first and second in terms of stem weight, while I_3 was different ($P<0.05$). In a study reported concerning stem weight, Harbaugh et al. (1985) determined the plant stem weight as 93 g in the treatment of 0.16 cm/day, 127 g in the treatment of 0.24 cm/day, 138 g in the treatment of 0.31 cm/day, 149 g in the treatment of 0.40 cm/day, and 168 g in the treatment of 0.47 cm/day in different daily irrigation water applications. Higher stem weights were obtained in the treatments treated with a large amount of water in our study, which is similar to these results. It was reported that the stem weight of a chrysanthemum of a high quality ranged from 25 to 105 g according to the classification criterion of the Dutch flower auction (Anonymous, 2010), while it was reported in Japan that the chrysanthemums which were 80-90 cm long should weigh 55-100 g (Yoon et al., 2000). Even though the stem weights in all experimental treatments are included in the good class according to the Dutch classification criterion, the stem weights of the flowers obtained from the experimental treatments other than T_4 are included in the good class according to the Japanese classification system.

Number of flower per plant: There were differences in the number of flowers in terms of both irrigation intervals and the irrigation water amounts applied. The difference between T_1 (28.60 flowers/plant) and T_2 (26.99 flowers/plant) was statistically insignificant. On the other hand, T_3 (20.19 flowers/plant) and T_4 (13.31 flowers/plant) were statistically different from each other. The differences in the number of flowers per branch between I_1 (24.64 flowers/plant) and I_2 and between I_1 and I_3 were significant, whereas the difference between I_2 (21.65 flowers/plant) and I_3 (20.53 flowers/plant) was insignificant ($P<0.05$).

Vase life: Irrigation interval and irrigation water amount had significant effects on vase life ($P<0.01$). The longest vase life among the irrigation intervals was determined in I_3 (17.82 days on average). However, the difference between I_1 (16.00 days) and I_2 (16.42 days) was insignificant. Although the difference among the irrigation water treatments was significant, there was no linear correlation either between the decrease and increase in irrigation water or between the increase and decrease in vase life. The longest vase life among all experimental treatments was recorded in I_3T_1 (19.67 days).

Table 4. Mean values and significance groups of quality parameters of spray cut chrysanthemum

Treatments	Stem length, cm			Average	Stem diameter, cm			Average
	I_1	I_2	I_3		I_1	I_2	I_3	
T_1	79.81 a	71.52 bc	73.75 b	75.03 A	7.69	6.77	6.68	7.05 A*
T_2	74.29 b	73.57 b	65.12de	70.99 B	7.10	6.73	5.98	6.61 B
T_3	67.18 d	67.93 cd	60.52 fg	65.21 C	6.74	5.78	5.72	6.08 C
T_4	62.58 ef	56.73 g	52.36 h	57.22 D	6.11	5.03	4.62	5.25 D
Average	70.96 A	67.44 B	62.94 C		6.91 A	6.08 B	5.75 C	
$LSD_{0.01}$	LSD_I:2.079, LSD_T:2.401, LSD_{IxT}:4.158				LSD_I:0.295, LSD_T:0.340			
	Stem weight, gr				Vase life, day			
T_1	123.61a	101.00b	101.54b	108.72 A	16.00 de	17.67a-d	19.67 a	17.78 A
T_2	85.82 c	95.24bc	70.31 d	83.79 B	14.00 e	16.33 cd	17.00 b-d	15.78 B
T_3	60.27 d	62.36 d	57.64 de	60.09 C	18.33 a-c	16.00 de	18.67 ab	17.67 A
T_4	45.86 ef	37.69 fg	32.48 g	38.67 D	15.67 de	15.67 de	16.33 cd	15.89 B
Average	78.89 A	74.07 A	65.49 B		16.00 B	16.42 B	17.82 A	-
$LSD_{0.01}$	LSD_I:6.558, LSD_T:7.573, LSD_{IxT}:13.120				LSD_I:1.158, LSD_T:1.337, $LSD_{I x T}$:2.317			
	Number of flower per plant, numbers				Root length, cm			
T_1	29.41ab	26.30bc	30.09 a	28.60 A	18.93	18.57	19.54	19.01 D
T_2	29.24ab	26.29bc	25.44 c	26.99 A	20.67	21.14	21.82	21.21 C
T_3	23.38cd	21.20 d	15.98 ef	20.19 B	21.71	22.68	23.07	22.49 B
T_4	16.53 e	12.80 fg	10.60 g	13.31 C	23.40	23.93	24.22	23.85 A
Average	24.64 A	21.65 B	20.53 B	-	21.18 B	21.58 B	22.16 A	
$LSD_{0.01}$	LSD_T:1.693, LSD_T:1.955, $LSD_{I x T}$:3.387				LSD_I:0.5429, LSD_T:0.6268			

*The difference among the averages is significant at 5% level.

Stem diameter: Stem diameter is an important criterion for determining the resistance of a branch. In terms of the irrigation water amounts, the thickest stem occurred in T_1 (7.05 mm on average), followed by T_2, T_3, and T_4. The stem diameters in these treatments were 6.61 mm, 6.08 mm, and 5.25 mm on average, respectively. When the irrigation intervals were examined, the thickest stem as found in I_1 (6.91 mm), followed by I_2 (6.08 mm on average) and I_3 (5.75 mm on average). The thickest stem was recorded in I_1T_1 (7.69 mm), to which the largest amount of water was applied at a 1-day interval, whereas the thinnest stem was obtained from I_3T_4 (4.62 mm) with the smallest amount of water application at a 6-day interval.

Root length: The longest root length was determined at T_4 (23.85 cm) which was applied the least irrigation water and also the lowest root length was determined at T_1 (19.01 cm) applied highest irrigation water. When the consideration irrigation interval, the highest root length was measured I_3 (22.16 cm). On the contrary, other quality parameters, when the irrigation water amount and irrigation interval increased, the root length was reduced. In other words, the lowest root length was obtained from T_1 which had the most irrigation water amount and highest irrigation interval. It is thought, due to the plants had not water stress and could easily get water from soil, the root growth in T_1 was better than applied less irrigation water such as T_4 or T_3.

CONCLUSIONS

The irrigation water amounts applied under experimental conditions ranged from 249.7 to 517.9 mm, while the plant water consumption varied between 340.9 and 560.5 mm. The large amount of irrigation water applied increased the plant water consumption, and its effect was reflected positively on the quality parameters;

hence, a longer stem and a higher stem weight were obtained from the treatments with a larger amount of water application and high plant water consumption accordingly. In the study, the longest stem (79.81 cm), the thickest stem diameter (7.69 mm) and the highest stem weight (123.61 g) were obtained from combination I_1T_1, while the largest number of flowers per plant (30.09 flowers/plant) and the longest vase life were determined in combination I_3T_1 (19.67 days). When stem length and stem weight are particularly considered in terms of marketable products, the optimum irrigation scheduling is I_1T_1. When it is intended to save water, treatment I_1T_2 or I_2T_2 might be selected as the irrigation scheduling. In this case, the reduction in flower quality will be minute.

ACKNOWLEDGEMENTS

This research was supported as a Master Thesis by Suleyman Demirel University Unit of Scientific Research Project (Project No: 2934-YL-11).

REFERENCES

Allen R.G., Pereria L.S., Raes D., Smith M., 1998. Crop Evapotranspiration. Guidelines for Computing Crop Water Requirements. Food and Agriculture Organization Irrigation and Drainage Paper No. 56. Rome, Italy.

Anonymous, 2010. Product specification chrysanthemum ındicum group. Ducth flower auction association (VBN) 7, Hollanda. http://www.vbn.nl/ (Erişim tarihi: 06.01.2013)

Anonymous, 2013. International Statistics Flowers and Plants 2013. AIPH-Union Fleurs 2013, 61, 165, The Netherlands.

Budiarto K., Sulyo Y., Dwi E.S.N., Maaswinkel R.H.M., 2007. Effects of irrigation frequency and leaf detachment on chrysanthemum grown in two types of plastic house. Indonesian Journal of Agricultural Science 8(1): 39-42.

Carvalho S.M.P. Heuvelink E., 2001. Influence of greenhouse climate and plant density on external quality of chrysanthemum (Dendranthema grandiflorum (Ramat.) Kitamura): first steps towards a quality model. Journal of Horticultural Science & Biotechnology 76: 249-258.

Carvalho S.M.P., Heuvelink E., Cascais R., Van Kooten O., 2002. Effect of day and night 408 temperature on internode and stem length in chrysanthemum: is everything explained 409 by DIF? Annals of Botany 90:111-118.

Conover C.A., 1969. Responses of Pot-Grown Chrysanthemum morifolium ‘Yellow Delaware’ to Media, Watering and Fertilizer Levels. Proceeding of the Florida State Horticultural Society, 82, 425-429.

Conte e Castro A.M., Macedo Junior E.K., Zigiotto D.C., Braga C.L., Sornberger A., Baldo M., Grisa S., Bianchini M.I.F., Sausen C., 2005. Effect of Irrigation Layers on Varities of Chrysanthemum for Cuttuing and on Soil Characteristics. Scientia Agraria Paranaensis, 4(2), 75-80.

DMİ. 2011. Devlet Meteoroloji İşleri Genel Müdürlüğü. Isparta MeteorolojiBölge Müdürlüğü Kayıtları. Isparta.

Doorenbos J., Kassam A.H., 1979. Yield Response to Water. Food and Agriculture Organization, Irrigation and Drainage Paper No. 33, 193. Rome.

Farias M.F., De Saad J.C.C, Denise M.C., 2009. Effect of soil-water tension on cut chrysanthemum floral quality and longevity. Applied Research & Agrotechnology 2(1): 141-145.

Fernandes A.L.T., Folegatti M., Pereira A.R., 2006. Valuation of different evapotranspiration estimate for (Chrysanthemum spp.) cultivated in plastic greenhouse. Irriga 11(2): 139-149.

Harbaugh B.K., Stanley C.D., Price J.F., 1985. Tricle Irrigation Rates for Chrysanthemum Cut Flower Production. Proceeding of the Florida State Horticultural Society, 98, 110-114.

Kazaz S., Aşkın M.A., Kılıç S., Ersoy N., 2010. Effects of day length and daminozide on the flowering, some quality parameters and chlorophyll content of Chrysanthemum morifolium Ramat. Scientific Research and Essays 5(21): 3281-3288.

Kiehl P.A., Lieth J.H., Burger D.W., 1992. Growth Response of Chrysanthemum to Various Container Medium Moisture Levels. Journal of American Society for Horticultural Science 114(2): 224-229.

Kofranek A.M., 1980. Introduction to Floriculture, Second Edition, Edited by R.A. Larson, Academic Press, 3-45, New York.

Lin L., Li W., Shoa J., Luo W., Dai J., Yin X., Zhou Y., Zhao C., 2011. Modelling the effects of soil water potential on growth and quality of cut chrysanthemum (Chrysanthemum morifolium) Scientia Horticulturae 130: 275-288.

Mengüç A (1996). Kesme Çiçek Yetiştiriciliği 3 (Kasımpatı). Anadolu Üniversitesi Yayınları No. 904, Açıköğretim Fakültesi Yayınları No. 486, 112-126, Eskişehir.

Parnell J.R., 1989. Ornamental Plant Growth Responses To Different Application Rates of Reclaimed Water. Proceedings of the Florida State Horticultural Society, 102, 89-92.

Rego J.L., Viana T.V.A., Azevedo B.M., Bastos F.G.C., Gondim R.S., 2004. Effects of irrigation levels on the chrysanthemum. Agronomic Science Magazine 35(2): 302-310.

Schuch U.K., Redak R.A., Bethke J.A., 1998. Cltivar, fertilizer and irrigation affect vegetative growth and susceptiibility of Chrysanthemum to western flower thrips. J. Amer. Soc. Hort. Sci 123(4): 727-733.

Steen M., 2010. A world of flowers: Dutch flower market and the market of cut flowers. J Appl Hortic 12: 113-121.
Uçar Y., Kazaz S., Aşkın M.A., Aydınşakir K., Kadayıfçı A. Şenyiğit U., 2011. Determination of irrigation water amound and interval for carnation (Dianthus caryophyllus L.) with pan evaporation method. Hortscience 46(1): 102-107.
Van der Ploeg A., Heuvelink E., 2006. The influence of temperature on growth and development of chrysanthemum cultivars: a review. Journal of Horticultural Science & Biotechnology 81(2): 174–182.
Villalobos R., 2014. Reduction of irrigation water consumption in the Colombian Floricculture with the use of tensiometer. http://irrigationtoolbox.com/ReferenceDocuments/TechnicalPapers/IA/2007/P1642.pdf (Erişim tarihi: 31.10.2014).
Waterland N.L., Finer J.J., Jones M.L., 2010. Abscisic acid applications decrease stomatal conductane and delay wilting in drought-stresses chrysanthemums. HortTechnology 20(5): 896-901.
Yoon H.S., Goto T., Kageyama Y., 2000. Developing a nitrogen application curve fır spray chrysanthemum grown ın hydroponic system and ıts practical use ın NFT system. Journal of the Japanese Society for Horticultural Science 69(4): 416-422.