Deficit Irrigation affect on Yield Performance of Pumpkin in Semi-arid Middle Anatolian Region of Turkey

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Abstract

Pumpkin (*Cucurbita pepo* L.) has been growth in most parts of Turkey. Almost none study was performed about irrigation water requirement or evapotranspiration of pumpkin plant in Turkey. This study, therefore, was conducted to determine different irrigation strategies affect on seed yield and quality parameters of drip irrigated pumpkin during periods 2013-2014. In research, five irrigation treatments of FI (I_{100}) known as full irrigation, %75 of FI (I_{75}), %50 of FI (I_{50}), %25 of FI (I_{25}) and %0 of FI (I_0) or no irrigation were examined by randomized block design with 3 replications. In result of combined two-years, seasonal evapotranspiration (ET_c) varied from 194.2 mm to 521.2 mm depending on treatments. The highest ET_c value was obtained from the I_{100} treatment for both years. The seed yield varied from 860 (I_{100}) and 234 (I_0) kg ha^{-1}. There was significant differences in seed yield, yield per fruit, number of seed per fruit, seed length, fruit length and fruit width, but none statistically significant differences was found in oil content, seed width, seed index and fruit index at significant level of 5%. According to the correlation analysis, relationship between irrigation water and yield was found significant.

Key words: Evapotranspiration, pumpkin seed yield, water use efficiency.

Introduction

The cultivated land of Konya plain of Turkey is about 8% (TSI, 2016). That area is characterized as arid climate with limited water resources. In terms of long-term climate records, rainfall of Konya plain is about 323 mm and only 90-100 mm of total rainfall has recorded within the crop growth season. Irrigation plays very important role for various crop productions as well as improvement of yield and quality due to the insufficient rainfall especially in crop production period.

The available water potential of Konya plain is about 4.45 billion m^3; 2.94 billion m^3 or 66% surface and 1.51 billion m^3 or 34% groundwater (Anonymous, 2015). In general, groundwater resources are used in irrigation at Konya plain. It is estimated that although safely extractable groundwater potential is 1.51 billion m^3, 1.8 billion m^3 is used in current (Anonymous, 2015). In accordance of that, overwater is extracted from groundwater reservoir so that water level has declined as well as there is deterioration in water quality. The depletion of water level is about 14-15 m during the periods 1974-2007 and is about 10 -11 m during periods 1997-2007 (WWF, 2008). The reason behind is overwater extraction from the groundwater resources.

Efficient water use in agriculture especially in arid and semi-arid regions is necessarily prerequisites. Crop patterns have to be reorganized in region in accordance of current water supply. In that regard, instead of increasing the cultivated lands with favor of high water consuming crops such as sugar beet, corn and carrot, pumpkin (well suited for various soils and climates) can be recommended in Konya region or similar environments. That crop even can be growth under no irrigation condition but yield reduction is very high in that case.

In addition to consuming of pumpkin seeds as snack, it is very nutritional for human health due to having rich of oil and mineral content as well as amino acid. Seeds have 35-40% of oil, 37% of carbohydrate, and 35-40 % of protein. It is also rich of some elements such Ca, K, Mg, Fe and Zn (Yanmaz and Düzeltir, 2003; Ondigi *et al.*, 2008).

Pumpkin seeds have consumed as snacks in long period in Turkey. Production area and yield have increased due to its high nutritional value for human health as mentioned above in recent years. Although pumpkin has produced widely at Nevşehir or around Nevşehir province in first, it is growth also other parts of Turkey in recent years. The production of pumpkin is common at Kayseri, Aksaray, Nevşehir, Konya, Edirne and Karaman cities. The pumpkin production of Turkey is about 10 000 tones according to 2004 records. According to the 2014 records of Turkish Statistical Council, production area and yield of pumpkin are 55000 ha and 36000 tones, respectively in Turkey. In same records, those are 1700 ha with 2240 tones in Konya province (TSI, 2016). Pumpkin is growth under irrigated conditions in Konya Plain. Little production has performed under rain-fed areas where the irrigation facility is not available. Yield of pumpkin is very low under the areas having no irrigation. Amer (2011) stated that excess or deficit irrigation has resulted yield reduction. Babayee *et al.* (2012) researched optimal irrigation water amount or plant density per unit area of pumpkin in İran. Irrigation water was determined in accordance of evaporation at Class A Pan. The plant densities of 6000, 8000, 10000 and 12000 plant/ha were studied. The highest seed yield of 84.1 g/plant was obtained from plant density of 6000 plant/ha. Yousefi (2012) studied the effect of different irrigation levels and Zinc doses on yield and quality of pumpkin in Iran. Irrigation was started when evaporated water reached to 50 mm and 100 mm and those amounts was applied as irrigation water. The highest seed yield was obtained from treatment with100 mm irrigation water.

In present study, effect of different irrigation levels on seed yield and quality of drip-irrigated pumpkin was researched in Konya province of Turkey by 2-year field experiment.

Material and Methods

The field experiment was performed for 2 years, 2013-2014, at Experimental Station of Agricultural Faculty, University of Selçuk. The research site is situated at Konya province of Turkey with 15 km far away from the Konya city center. The geographical position of research site is 38° 02′ North Latitude and 32° 30′ East Longitude with 1105 m above the sea level.

Table 1. Some chemical and physical characteristics of research soil

Soil Depth (cm)	pH	Organic Matter (%)	Texture	Bulk Density (g cm^{-3})	Field Capacity (FC)		Permanent Wilting Point (PWP)		Available Water Capacity	
					m^3m^{-3}	mm	m^3m^{-3}	mm	m^3m^{-3}	mm
0-30	7.78	1.74	SCL	1.41	0.285	85.4	0.149	44.8	0.135	40.6
30-60	7.82	1.17	SCL	1.38	0.301	90.3	0.160	48.0	0.141	42.2
60-90	7.82	0.35	SCL	1.42	0.285	85.6	0.141	42.2	0.145	43.5
Total						261.3		135.0		126.3

The pH, organic matter, texture, bulk density, field capacity, permanent wilting point and available water capacity of research site are listed in Table 1. In table, soil is sandy-clay- loam (SCL). The pH, organic matter, bulk density, field capacity as volumetric percentage and available water capacity are 7.78 – 7.82, 0.35% –1.74%, 1.38 - 1.42 g cm^{-3}, 28.5% - 30.1% and 126.3 mm, respectively. In result, there is no limitation for pumpkin farming according to the chemical and physical characteristics of study site.

Some meteorological parameters were recorded during periods 2013-2014 by using a portable automatic meteorological station (Davis Vantage Pro2) in the experimental site. Long-term meteorological data were obtained from Konya Meteorological Directorate (Table 2). In Table 2, total rainfall during growing season of May-September for 2013 and 2014 were 59.2 mm and 83.6 mm, respectively. In accordance of seasonal average data, there was a similarity between experimental years of 2013-2014 and long term average.

In research, pumpkin local variety of Urgup Sivri, very common in Turkey, was used as a crop material. It is produced for pumpkin seeds in Middle Anatolian Region of Turkey. The seeds of Urgup Sivri are characterized as 20-22 cm in length, long, narrow, thick edge, fat and very fragile. In research, five different irrigation treatments namely I_{100} (full irrigation, FI), %75 of FI (I_{75}), %50 of FI (I_{50}), %25 of FI (I_{25}) and %0 of FI (I_0, no irrigation) was used by 21 days irrigation intervals with randomized block design with 3 replications.

Irrigation water was taken from pipelines of fresh water from the Campus of Selcuk University. The water was analyzed by procedures as suggested by Ayyıldız (1990), and according to the analysis, irrigation water quality was classified as C_2S_1 (second class as salinity and first class as alkalinity) by using USSL graphical technique.

Water was delivered to the plots by drip irrigation system. The characteristics of such system was as follows: lateral tube with 16 mm in diameter (4 L/h emitter discharge under 1 atmosphere working pressure), mainline with 50 mm in diameter and 32 mm in diameter of manifold. Emitter spacing of lateral tube was selected according to the soil properties (Yıldırım, 2003). The amount of irrigation water was measured by using the ¾ inch flow meters at the inlet of the plots. Drip irrigation system was installed to the all plots just prior to the seed sowing. The day before the seed sowing, as pure form of 50 kg N/ha, 50 kg P_2O_5/ha and 50 kg K_2O /ha fertilizers were applied to the experimental soil.

Pumpkin seed were sown 10 May 2013 and 12 May 2014. Seeds were planted in 1.0 m row spacing with 0.5 m plant spacing. Three seed were sown in one place and after the germination; seed were thinned up to one seedling in one hole. In research, plots were 5 m in length and 4 m in width (four rows in plot and about total 40 plants in plot). One lateral tube was installed for each plant row. The 2.5 m space was between block and plot. Just after planting, for uniform germination and successful seedlings, irrigation water of 33 mm and 42 mm were applied for

2013 and 2014, respectively to the whole plots. In the fruit formation stage, pure 50 kg N/ha was applied at both years. The other cultural practices were performed in the required times in both research years. The outer parts of the plots were ignored just before the harvest of 24 September in both years.

Table 2. Some climate parameters in research and long years

Months		Mean. Max. Temperature (°C)	Mean. Min. Temperature (°C)	Mean Wind Speed (m s^{-1})	Mean Relative Humidity (%)	Rainfall (mm)	Mean Solar Radiation (MJ m^{-2} day^{-1})	Mean Daily Sunshine Hours (h)
May	2013[a]	25.2	11.4	2.2	59.8	46.6	23.5	7.8
	2014[b]	24.4	8.3	2.0	57.5	7.4	24.3	8.5
	53 year[d]	22.2	8.5	2.2	55.9	43.8	25.0	8.5
June	2013	28.4	14.4	2.9	47.8	8.8	25.8	10.6
	2014	26.4	12.5	2.6	55.9	55.6	24.9	9.3
	53 year[d]	26.6	12.7	2.5	48.4	22.9	27.8	10.4
July	2013	29.5	17.3	3.3	40.1	0.8	27.2	11.1
	2014	32.0	16.7	3.2	44.3	9.6	27.7	11.3
	53 year[d]	30.0	15.9	2.8	42.1	6.8	28.7	11.4
August	2013	30.0	17.1	3.0	39.4	-	26.1	11.2
	2014	32.4	17.5	3.1	43.5	2.8	24.9	11.1
	53 year[d]	29.9	15.4	2.6	42.9	5.5	26.6	11.1
September	2013[c]	25.2	11.2	2.3	47.6	3.0	18.7	9.7
	2014[c]	27.0	12.6	2.1	58.1	8.2	18.5	9.4
	53 year[d]	26.0	11.0	2.1	48.0	11.0	22.1	9.4
Seasonal	2013	27.7	14.3	2.7	46.9	59.2	24.3	10.1
Average	2014	28.4	13.5	2.6	51.9	83.6	24.1	9.9
	53 year[d]	26.9	12.7	2.4	47.5	90.0	26.0	10.2

[a] Calculated from data between 10 and 31 May (10 May is sowing date of 2013)
[b] Calculated from data between 12 and 31 May (12 May is sowing date of 2014)
[c] Calculated from data between 1 and 24 September (24 September is the fruit harvest for both 2013 and 2014)
[d] 53 year: Means of 1960-2013.

Soil moisture content was measured by using the gravimetric method. Those measurements were performed at seed sowing, before each irrigations and fruit harvest at 0-30, 30-60, 60-90 and 90-120 cm soil depths. Irrigation water was calculated by using Eqn. 1 and 2.

In research, irrigation water of full irrigation treatment of (I_{100}) in the 0-90 cm soil depth with 21 days irrigation intervals was calculated first, and applied water for other treatments were determined in accordance of water requirement of full irrigation treatment.

$$d_n = \frac{(FC\text{-SWC}) \acute{} D}{10} \quad \textbf{(1)}$$

where;

d_n- irrigation water (mm), FC- Moisture Content at Field Capacity (Volumetric Percentage, %), SWC- Soil Water Content before irrigation (Volumetric Percentage, %), D- root zone dept, cm.

$$I = d_n \times A \times P \times IL \quad \textbf{(2)}$$

Where;

I-Amount of irrigation water (liter), A- parcel area (m^2), P- wetted percentage, IL- Irrigation Levels depending on treatments.

As seen Eqn. 2, by multiplying the dn, plot area of A, wetted percentage and irrigation Level (IL), irrigation water (I) to be applied to each plots can be obtained as liter (L).

P value was calculated as 65% (Keller and Bliesner (1990)); *IL*: (I_{100}=1.00; I_{75}=0.75; I_{50}=0.50; I_{25}=0.25 and I_0=0.00).

Crop water use, ET, was calculated by using following Eqn. as suggested by James (1988);

$$ET = I + R - D_P + C_r - R_f \pm \Delta S \quad \textbf{(3)}$$

where;

ET: Evapotranspiration (mm); I: Applied water (mm), R: Effective rainfall (mm); D_p: deep percolation (mm); C_r: Capillary rise (mm); R_f: Run off (mm); ΔS: Changes of soil moisture content in soil profile (mm).

R was determined from the portable meteorological station at research site, and D_p was calculated after irrigation event by measuring the soil moisture content by gravimetrically between 90 cm and 120 cm depths. In research, none deep percolation was observed at lower part of 90 cm. Research soil is deep and no drainage or salinity problems so C_r value was ignored since none capillary raises from water table were exist. ΔS was determined by measurements of soil moisture contents at times of seed sowing and fruit harvest. Drip irrigation system was managed well so none run off losses were observed; Therefore, R_f value was also ignored.

Water use efficiency, WUE, and irrigation water use efficiency, IWUE (indicator of efficiently using of unit irrigation water) were calculated by Tanner and Sinclair (1983).

Variance analysis was applied to the data of yield and yield components such as seed yield, seed yield per fruit, seed number per fruit, fruit diameter, fruit length, row oil content, seed length, seed width. The characteristics having significant were grouped by using LSD (Least Significant Difference) in the 5% significance level (Efe *et al.,* 2000). SPSS 22.0 packet program was used for variance analysis and LSD tests.

Results and Discussions

Applied Water and Evapotranspiration

Irrigation number, applied water, effective rainfall, evapotranspiration and I_{rc} (compensating irrigation water to the crop water use) are listed in Table 3. In the exceptions of water application at germination and seedlings, total 4 irrigations was performed. The highest applied water was in the treatment of full irrigation, I_{100}. In such treatment, total applied water for 2013 and 2014 was 370 mm and 336 mm, respectively. Total rainfall at the vegetation periods for 2013 and 2014 were 59.2 mm and 83.6 mm, respectively. The most of the rainfall recorded in vegetation period of pumpkin plant in both research years was between seed sowing date (10 and 12 May) and the date of the starting treatment irrigation (12 June). The experimental site is flat topography and rainfall was not enough to increase the soil moisture content up to the field capacity. Therefore, all rainfall was assumed as effective rainfall in the calculation of evapotranspiration. Evapotranspiration for 2013 and 2014 was calculated as 194.2-521.2 mm and 208.6 mm – 493.6 mm, respectively. The highest evapotranspiration as

an average 507.4 mm for both two-year was obtained from full irrigation treatment of I_{100}. Irc, irrigation water compensation for evapotranspiration, was 17-71% and 20-68% for 2013 and 2014, respectively. Decreasing irrigation water resulted in reduction in I_{rc} values. Amer (2011) reported that seasonal evapotranspiration varied from 238 mm and 344 mm for drip or furrow irrigated summer squash depending on irrigation techniques as well as research years.

Fandika et al. (2011) stated seasonal evapotranspiration of summer squash and pumpkin were 413 mm and 408 mm, respectively.

Ertek et al. (2004) studied crop water use and yield parameters of furrow irrigated summer squash under Van province of Turkey. Depending on irrigation levels, irrigation water and crop water use varied from 279 mm to 475 mm and from 336 mm and 539 mm, respectively.

Çakır (2000) researched effect of deficit irrigation in phenolgical stages on seed yield of pumpkin at three-year field experiment in Trakya province of Turkey. The phenologic stages were as follows: (A) - Appearance of first flowers, (B) - Fruit development (about 20 days after the flowering), and (C) - Seed formation (about 40 days after flowering). The highest applied water was found as about 394.5 mm under irrigation in all three stages of ABC.

Yield and Quality Parameters

Seed yield, seed oil ratio, seed yield per fruit, seed number per fruit, WUE and IWUE are presented in Table 4; seed length, seed width, seed index, fruit length, fruit width and fruit index are listed at Table 5. Variance analyze, ANOVA, was performed to decide whether combine analyze will be done or not for two-year data. The applied test showed that there was no homogeneity in data for each experimental year. Therefore, data about yield and quality parameters for each year were evaluated separately.

In Table 4, the maximum seed yield for 2103 as 860 kg/ha and 2014 as 839 kg/ha was obtained from the full irrigation of I_{100}, and difference between full irrigation and 25% deficit irrigation of I_{75} was not found significant in level of 5% significant level in accordance of LSD test. The seed yield of pumpkin is about 800-900 kg/ha in irrigated condition of Konya plain.

Table 3. Total applied water and crop water use (ET)

Years	Treatments	Irrigation Number	Irrigation Water (mm)	Effective Rainfall (mm)	ΔS (mm)	*ET* (mm)	I_{rc} (%)
2013	I_{100}	4	370	59.2	92	521.2	71
	I_{75}	4	297.8	59.2	96	453.0	66
	I_{50}	4	225.5	59.2	93	377.7	60
	I_{25}	4	153.3	59.2	96	308.5	50
	I_0	-	33	59.2	102	194.2	17
2014	I_{100}	4	336	83.6	74	493.6	68
	I_{75}	4	270	83.6	80	433.6	62
	I_{50}	4	204	83.6	88	375.6	54
	I_{25}	4	138	83.6	93	314.6	44
	I_0	-	42	83.6	83	208.6	20

The findings of our present study at full irrigation are inline with Konya average of previous research. Nerson (2005) also stated the highest seed yield of pumpkin as 1100 kg/ha with a plant density of 4 plant/m^2 and such result is higher than the finding of our study.

Ghanbari et al. (2007) reported maximum seed yield of pumpkin as 970 kg/ha under 7 day irrigation interval at Iran. Those researchers also suggested the optimal irrigation interval or plant spacing as 7 days and 100 x 40 cm (100 cm row with 40 cm on plants). Amer (2011)

stressed that squash plant is very sensitive to the deficit or over irrigation so significant yield reductions can be witnessed under both those conditions.

In both two-year research years, seed oil content was measured as 35% and oil contents among the treatments were almost similar. The differences of seed oil contents in all treatments were not found significant statically. There was similarity between variation of oil yield and seed yield. Increasing the applied water to the treatments resulted increase in the seed number per fruit, and maximum seed number per fruit was obtained from the full irrigation (I_{100}).

WUE varied from 0.16 to 0.25 kg m^{-3} for 2013; from 0.11 to 0.18 kg m^{-3} for 2014. As seen in Table 4, although, maximum WUE was obtained from no irrigation treatment (I_0) in 2013, it was the highest in I_{75} treatment in 2014. Differences in WUE for research years could be resulted from the climate characteristics. Especially in 2014, high temperature with low relative humidity at fruit formation stage decreased the seed yield. This caused reduction in WUE in control treatment (no irrigation) at 2014. IWUE, important indicator of the performance of irrigation program, was calculated as 0.23-1.47 kg m^{-3}, and 0.22-0.56 kg m^{-3} for 2013 and 2014, respectively. The maximum IWUE was calculated from the control treatment of I_o, for both study years. In many studies conducted to determine the water-yield relationships, values of WUE and IWUE are parallel, but in present study, IWUE values were the highest at I_o treatment. The reason behind that 300 - 400 kg/ha seed yield was obtained from those treatments.

As seen from Table 5, by evaluation of combine year together, seed length, seed width, seed index, fruit length, fruit width and fruit index varied from 18.2 to 20.6 mm, from 8.2 to 9.1 mm, from 2.20 to 2.33, from 132 to 159 mm, from 120 to 165 mm, and from 0.96 to 1.11, respectively.

Table 4. Seed Yield, Oil Content, Oil Yield, number of seed per Fruit, WUE and IWUE

Years	Treatments	Seed Yield (kg ha^{-1})	Seed Oil Content (%)	Seed Yield Per Fruit (g fruit^{-1})	Seed Number per Fruit (Number Fruit $^{-1}$)	WUE (kg m^{-3})	IWUE (kg m^{-3})
2013	I_{100}	860a	35.5	39.1ab	229	0.17bc	0.23d
	I_{75}	734ab	35.6	44.4a	277	0.16c	0.25cd
	I_{50}	715b	31.8	38.9ab	235	0.19bc	0.32c
	I_{25}	612b	35.3	34.8b	226	0.20b	0.40b
	I_0	484c	35.3	32.2b	209	0.25a	1.47a
	$LSD_{0.05}$	126.3	ns	7.55	ns	0.04	0.08
	CV (%)	9.8	4.3	10.6	12.7	10.4	8.4
2014	I_{100}	839a	37.0	42.3a	227a	0.17ab	0.25b
	I_{75}	782a	35.2	43.1a	221a	0.18a	0.29b
	I_{50}	445b	32.8	32.5b	192b	0.12b	0.22b
	I_{25}	335bc	33.8	25.3b	154c	0.11b	0.24b
	I_0	234c	34.1	27.2b	180bc	0.11b	0.56a
	$LSD_{0.05}$	192.4	ns	7.52	27.8	0.06	0.10
	CV (%)	19.4	7.8	11.7	7.6	23.0	17.6

ns: None significant.

Table 5. Findings About Seed and Fruit Characteristics

Year	Treatments	Seed Length (mm)	Seed Width (mm)	Seed Index	Fruit Length (mm)	Fruit Width (mm)	Fruit Index
2013	I_{100}	20.6a	9.1	2.25	159	165a	0.97
	I_{75}	19.5ab	8.4	2.33	144	150a	0.96
	I_{50}	19.5ab	8.4	2.33	149	151a	1.00
	I_{25}	18.2b	8.3	2.20	148	147a	1.01
	I_0	18.2b	8.2	2.22	138	125b	1.10
	$LSD_{0.05}$	1.66	ns	ns	ns	19.0	ns
	CV (%)	4.6	4.4	3.4	4.7	6.8	5.4
2014	I_{100}	19.9	8.7	2.29	159a	149a	1.07
	I_{75}	18.6	8.0	2.33	158a	151a	1.05
	I_{50}	19.8	8.8	2.24	153a	142a	1.08
	I_{25}	18.8	8.2	2.31	150a	135ab	1.11
	I_0	19.4	8.8	2.20	132b	120b	1.11
	$LSD_{0.05}$	ns	ns	ns	13.9	21.0	ns
	CV (%)	4.3	6.9	5.7	4.9	8.0	7.2

Table 6. Correlation coefficients between irrigation water and yield components

	Iwa	Sy	Sop	Syf	Nsf	Sl	Sw	Si	Fl	Fw	Fi
Iwa	1.00	0,99**	0,37	0,88*	0,80	0,74	0,38	0,75	0,94*	0,97**	-0,95*
Sy		1,00	0,48	0,93*	0,86	0,72	0,37	0,75	0,88	0,92*	-0,93
Sop			1,00	0,39	0,37	0,14	0,12	0,08	0,23	0,22	-0,25
Syf				1,00	0,99**	0,57	0,18	0,87	0,68	0,79	-0,92*
Nsf					1,00	0,47	0,08	0,88	0,57	0,70	-0,87
Sl						1,00	0,86*	0,25	0,68	0,66	-0,54
Sw							1,00	-0,22	0,35	0,29	-0,10
Si								1,00	0,64	0,76	-0,92*
Fl									1,00	0,99**	-0,88*
Fw										1,00	-0,95*
Fi											1,00

*: Correlation is significant at the 0,05 level (P<0,05), **: Correlation is significant at the 0,01 level (P<0,01), Iwa: Irrigation water amount, Sy: Seed yield, Sop: Seed oil percentage, Syf: Seed yield per fruit, Nsf: Number of seed per fruit, Sl: Seed length, Sw: Seed width, Si: Seed index, Fl: Fruit length, Fw: Fruit width, Fi: Fruit index

Correlation analysis was used to determine relationships between irrigation water and yield parameters among the all yield components. Correlation coefficients are presented in Table 6. Positive correlation was found between seed yield, yield per fruit, fruit length and fruit width, and applied water in significant levels of 1% and 5%. However, negative correlation was found between applied water and fruit index in 5% significant level.

Results and Recommendations

Pumpkin plants with still limited production are growth in areas where irrigation facilities are not available or rain-fed conditions in Konya Plain. In examine the findings of present study, significant seed yield reductions were seen in none irrigation condition by comparison to full irrigation. In the other word, seed yield of pumpkin under irrigation has increased about 2.5 times. As a result of our two years field study, maximum seed yield of pumpkin under 21 day irrigation intervals was obtained from the full irrigation conditions. On the other hand, efficient use of water resources is great interests in water shortage environments such as Konya plain. In that regard, deficit irrigation is needed in many crops in such regions. In regions having the similar environment of Konya, 75% of full irrigation or 25% deficit irrigation under 21 day irrigation intervals for pumpkin plant can be highly recommended for water saving. In that case, although seed yield reduction is only about 10%, water saving is around 70 mm or 20%. In conclusion, results of the present study is original and those will be beneficial for farmers who are interested in pumpkin plant production in first, and others such as irrigation organizations and researchers.

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