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GROWING OF MELON IRRIGATED WITH DRIP IRRIGATION

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Abstract

Agriculture is the sector that has the largest share among water users. It has become a necessity to use natural resources, especially water and soil efficiently and sustainably. For this reason, it is very important to develop irrigation programs that will allow saving of irrigation water used in agriculture and to use common drip irrigation systems which are advantageous in this regard. In recent years, the use of drip irrigation systems has become widespread in the irrigation of field crops and orchards. As in many plants, the fact that the water needs of the plants are met with irrigation practices for the cultivation of melons when rainfall is not enough causes significant increases in yield. However, in the cases where water resources are scarce and/or the costs of irrigation are high, deficit irrigation methods should be considered. In this research, the application of irrigation water at different levels with the drip irrigation method in melon cultivation is examined.

Key words*: deficit irrigation, melon, water use, water-yield relationship.*

INTRODUCTION

The values regarding the rank of Turkey in the market were examined in a study that examined the statistics regarding the world melon market and interesting figures were found out. It was found in that study that Turkey had almost no share in the international melon market which is calculated to have about 1.3 billion value in US Dollar. However, Turkey comes after China in melon production in the world. Spain which is ranked 6th in melon production with 3.51% share of world melon production exports about $ 300 million worth of melon. Turkey is reported to have significant capacity in terms of melon export (Çelik and Çelik, 2012). In this context, there is a need to increase the cultivation of melon species which are efficient, high quality and could be stored for longer periods after harvest with the use of proper farming techniques in Turkey to meet the market demand.
Water is a critical factor for achieving high quality and efficiency in the cultivation of many products in agriculture. Irrigation is a necessity for highly efficient production in the cases when precipitation is not enough to meet plants' water needs. However, global warming and climate change, as in many countries, is threatening freshwater resources in Turkey. Turkey is a country which has mild climate conditions in the northern hemisphere, and it is prone to the effects of climate change and global warming. Naturally, due to the fact that it is surrounded by seas on three sides, that it has a rugged topography and orographic features, different regions of the country are affected differently from climate change in different dimensions.
For example, in the arid and semi-arid regions, such as the South East and Central Anatolia, which are under the threat of desertification because of the increase in temperature, the semi-humid Aegean and Mediterranean regions, which do not have sufficient water, are highly affected. The changes in climate will cause also changes in agricultural activities, natural habitats of animals and plants, and there will be significant problems in terms of water resources, especially in the above-mentioned regions (Öztürk, 2002).
Agriculture is the sector with the largest share among the water using sectors. However, the sustainability of this is controversial. Nowadays, various studies are carried out in order to reduce usage in the agricultural sector.

The efficient and sustainable use of natural resources, especially water and soil, has become a necessity. For this reason, it is very important to develop irrigation programs that will allow saving in the used irrigation water and widespread use of a drip irrigation system which is advantageous with this regard. In recent years, the use of drip irrigation systems in the irrigation of field crops and orchards have become more widespread in Turkey. However, drip irrigation is used by farmers as an irrigation method in the cultivation of melon plant as it facilitates water conservation, effective fertilization and increases the effectiveness of pesticides used in agriculture

In spite of the modernization of the water transmission and distribution systems, production is made in agriculture with the use of excessive or incomplete irrigation and as a consequence of that, there may be losses in the yields. In other words, since an appropriate irrigation program is not applied in the production, the actual yield potential of plants cannot be achieved. However, it should also be considered that water deficit programs as alternative irrigation may be offered to farmers if there is not enough water in the future or the cost of water is high. In Turkey, the melon is produced in Aegean, Marmara, Central Anatolia, Eastern Anatolia, South eastern Anatolia and the Mediterranean regions. However, the Antalya region, where the research was carried out, has significant advantages thanks to the moderate climatic conditions for the cultivation of melon both in greenhouse and field agriculture.

In this study, the response of different melon species was investigated to deficit irrigation.

MATERIALS AND METHODS

The study was carried out on the land of West Mediterranean Agricultural Research Institute located 20 km east of Antalya province near the Antalya-Alanya highway. The research site is located at 36^0 52′ north latitude and 30^0 50′ east longitude and the average elevation is 15 m. The research area has the type of soils with clayey loam and clayey loam silty structure, and there is not any drainage problem. For the 0 - 90 cm layer of the soil in the research area, the average volume weight is 1.37 g/cm^3, the value for the field capacity for the same layer is 34.5% in volume, the wilting point value is 19.8%. The irrigation water used was provided by pumping from the deep well in the research area. Irrigation water is classified as C2S1 according to the US Riverside Salinity Laboratory classification system, and it is suitable for agricultural production. In the research, Westeros, KÇ-4 and Ünlü cultivars were used as plant material. Drip irrigation method was used as an irrigation method in the research. The treatments consisted of 12 treatments as 4X3 factor combination, 4 irrigation levels and 3 melon cultivars. Each treatment was applied in the field according to the trial design in randomized blocks with three iterations.

In drip irrigation system, dripper laterals were placed at the nearest point to the plant in a way to be lateral to each plant line. The parcels were arranged so that the distance between the plants was 1.5 m and the distance from the plant was 1 m and the row length was 15 m. The area of a parcel was 15 m x 4.5 m = 67.5 m^2. In the drip irrigation system, laterals had a diameter of 16 mm and drippers had a flow rate of 4 L/hour. The distance between the drippers was 0.5 m. The manifold pipeline was made of polyethene (PE) material, and it was resistant to 50 mm diameter and 8 atü pressure. The main pipeline was made of PE material with a pressure of 90 mm and a pressure of 10 atm. The control valve, pressure gauge and water meter were installed while passing from the main pipeline to the manifold pipeline. After the pump unit of the irrigation system, there are 2-inch hydrocyclones, 150 mesh sieve filter, ball valve and manometer. Butterfly valves were placed in the irrigation system at the beginning of laterals.

Irrigation applications in the 100% irrigation treatment were applied to complete the field water capacity when 30-40% of the water in the soil was consumed. In the treatment in which deficit irrigation was applied: (1) I100, when 30-40% of the water is consumed in the soil, the existing soil water content is completed to the field capacity; (2) I80, in each irrigation, 80% of the irrigation water applied to the I100 treatment was applied; (3) I60, in each irrigation, 60% of the irrigation water applied to the I100 treatment was applied; (4) I40, in each irrigation, 40% of the irrigation water applied to the I100 treatment was applied.

In the study, soil moisture content was observed in three layers in 0-30, 30-60 and 60-90 cm depths from the soil surface by gravimetric method. In the soil samples taken before the irrigation, the moisture content of the three layers was determined and the soil moisture content was determined for 0-90 cm depth (Yıldırım et al. 2009).

Irrigation treatments were planned as control treatment (I100) in which the moisture was completed to the field capacity and the treatments in which 80%, 60% and 40% of the amount of water applied to the control treatment were applied.

The soil moisture content before the irrigation was found out for each treatment, and the amount of irrigation water to be applied was calculated by using the following equation.

$$\mathrm{d} = \left(\frac{\mathrm{TK}_{0-90} - \mathrm{MN}_{0-90}}{100}\right)\mathrm{D} * \mathrm{P}$$

In the equation,

d = quantity of irrigation water applied,

TK0-90 = 0-90 cm is the field capacity in the soil layer (in the form of volume percentage),

MR0-90 = Moisture measured in the soil layer at the start of irrigation 0-90 cm (in the form of volume percentage, %),

D = is the depth of soil layer, mm (90 mm) and

P = wetted area ratio.

In the study, the wetted area ratio was calculated by measuring the wet strip width up to 30-40 cm of soil depth at the beginning, middle and end of the laterals, at the beginning and near the end of the manifold measuring the average value to the lateral range.

The amount of irrigation water that should be given to each treatment was applied according to the irrigation time with the help of the equation below (Yıldırım et al. 2009).

$$Ta = \frac{1000\, d}{q\, N}$$

In the equation:

Ta = Watering time, hour,

d = amount of irrigation water to be applied, mm,

q = dripper flow rate,

L hour-1 and

N = number of unit area drippers (1333 pcs/da).

RESULTS AND DISCUSSIONS

This study was planned to continue for two years and the field studies for the second year have not started yet. In this paper, some of the data regarding the first year of the study were shared.

The total amount of irrigation water applied to the treatments discussed in the study ranged from 75 mm to 136 mm in the Westeros species, between 145 mm and 79 mm in the Ünlü species, and 143 mm to 78 mm in the KÇ-4. In the study, the yield values obtained according to irrigation levels ranged from 39.3 to 44.7 t/ha in Westeros cultivar, 36.2 to 43.1 t/ha in Ünlü, and 32.5 to 41.2 t/ha in KÇ-4 (Figure 1).

Sharma et al. (2014) reported that the marketable yield of melon plant ranged between 45.5 and 61.0 t/ha.

Wang et al. (2017) stated that when irrigation water ranging from 151 to 189 mm was applied, it was found that the marketable yield obtained in the melon plant was between 32.4 and 54.4 t/ha.

In the study, an increase in the yield was observed in all species in general as irrigation water levels increased.

However, there was no significant difference between the yield obtained under the conditions in which 100 mm irrigation water was applied and the yield obtained when 122 mm irrigation water was applied in the Ünlü.

Nevertheless, it could be said that there is a positive relationship between yield and irrigation water.

The highest correlation coefficient for the relationship between yield-irrigation water, R^2=0.99 was obtained in Westeros cultivar. For KÇ-4 was R^2=0.94 and Ünlü was R^2=0.88 (Figure 1).

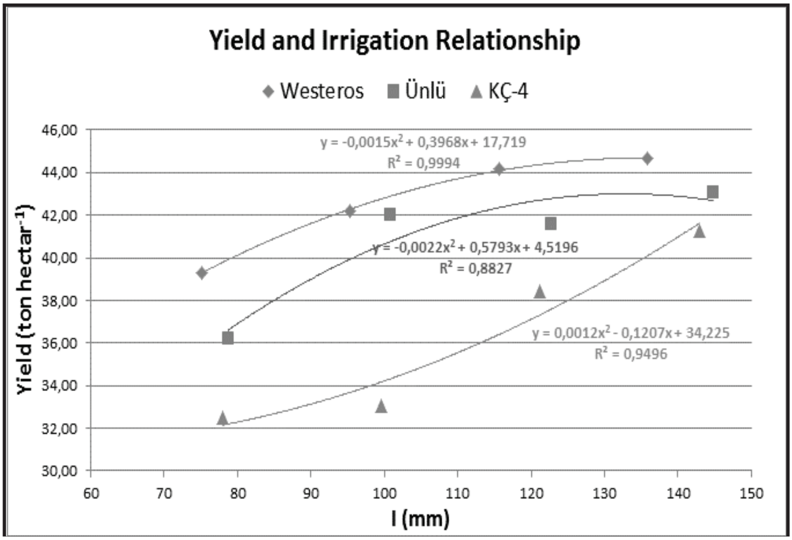

Figure 1. Change in the yield due to the amount of irrigation water.

Sensoy et al. (2007) found out that the determination coefficient of the mathematical equation in which water-yield relationship was calculated for the melon plant was calculated as R^2=0.81. In our study, the correlation coefficient (R^2) was found to be higher for the relationship between yield-irrigation water.

Seasonal plant water consumption (ET) values of melon species in the study ranged from 241 mm to 278 mm in Westeros cultivar, between 246 mm and 284 mm in Ünlü species, and 239 mm to 277 mm in KÇ-4. The yield in the species increased in general as the ET value increased, and a positive relationship was found between ET value and yield. In the study, Westeros (R^2 = 0.95) was found to be the cultivars for which the relationship between ET and yield was estimated with the highest accuracy. The yield coefficient of the equation was calculated as R^2 = 0.94, while the correlation coefficient for the relationship between ET was found to be R^2 = 0.76 for Ünlü (Figure 2).

Kirnak et al. (2009) stated that yield decreases due to water stress as ET value decreases. Similarly, they found the coefficient of determinent for the mathematical equation to be calculated as ET = 0.99 (Kirnak et al., 2009).

Castellanos et al. (2016) conducted a study in which they examined irrigation practices in which they used water having different nitrogen values and found that the ET values in melon plants ranged from 356 to 472 mm, that the obtained yield ranged between 32.4 and 52.0 t/ha.

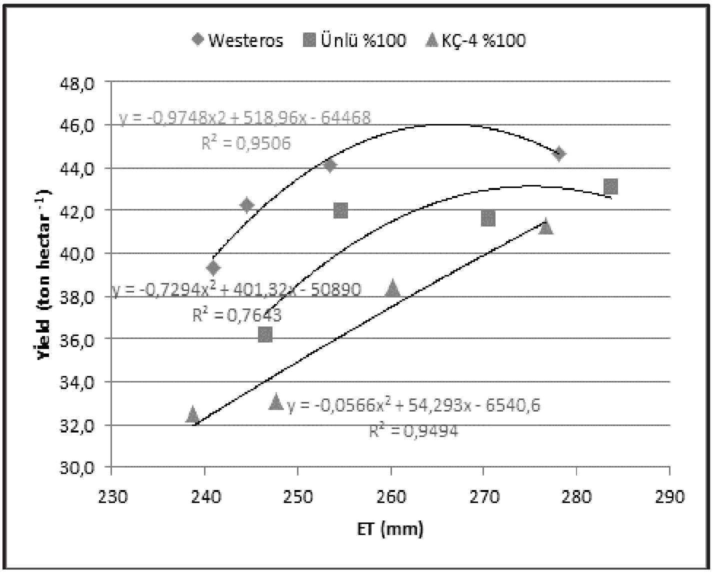

Figure 2. Plant water consumption (X = ET, mm) and yield relationship

In the study, Westeros was found to be the species for which the relationship between ET and yield was estimated with the highest accuracy. Kirnak et al. (2009) stated that yield decreases due to water stress as ET value decreases.

Castellanos et al. (2016) conducted a study in which they examined irrigation practices in which they used water having different nitrogen values and found that the ET values in melon plants ranged from 356 to 472 mm, that the obtained yield ranged between 32.4 and 52.0 t/ha.

The irrigation water usage efficiency (IWUE) was the highest for I40 treatments when the averages for irrigation levels were compared. No difference was found between the I60 and I80 treatments. The average regarding the lowest irrigation water usage efficiency was for I100.

The irrigation water use efficiency (IWUE) in the Westeros cultivar was found to be higher than the other two cultivars. The highest water use efficiency (WUE) average was Westeros. The second highest average was Ünlü. Among the irrigation levels, the highest usage efficiency was at I80.

When Brix values were examined, it was seen that two statistical groups were formed among the cultivars. While Westeros and Ünlü cultivars were in the same statistical group, KÇ-4 was included in a sub-group with lower Brix value mean (5.4%). There were also two statistical groups among the irrigation levels. While I40, I60 and I80 were in the same group, Brix value of I100 treatments (5.6%) was lower than the values of other irrigation levels.

When the averages of cultivars X irrigation level interaction were examined, it was seen that the Brix values ranged between 5.1 and 8. While I40, I60 and I80 irrigation levels in the Ünlüand Westeros species had the highest Brix values, these values varied between 8 and 7.4. In these two species, the Brix values between I40 and I80 levels were in the same statistical group. However, there was a decrease in the brix values in Westeros and Ünlü species at the 100% irrigation level.

The mean of the X cultivars's irrigation level interaction was between 5.6 and 5.1 in K-4 and there was no statistically significant difference between the brix values of this species. I40 and I80 treatments of KÇ-4 species are in the same statistical group with Westeros and I100 treatments of Ünlü cultivars.

However, the I60 and I100 treatments in the KÇ-4 species were in a sub-group compared to the I100 treatment of Westeros and Ünlü cultivars. In other words, the decrease in the brix values of I60 and I100 treatments was more remarkable in the KÇ-4 cultivar. In a study conducted in Çanakkale province, it was reported that the brix values in melon plant ranged between 11.4 and 13 (Tekiner et al. 2010).

In another study, which studied Kırkağaç melon species, the brix values varied between 6 and 9.2 (Yıldırım et al. 2009). Özbahçe et al. (2014) conducted a study on Edalı F1 melon hybrid, the brix values were found to range between 6.3 and 10.

The brix values obtained in our study were found to be lower compared to brix values reported by Özbahçe et al. (2014) and Tekiner et al. (2010) but found to be similar to those reported by Yıldırım et al. (2009).

CONCLUSIONS

The total amount of irrigation water applied to the treatments discussed in the study ranged from 75 mm to 136 mm in the Westeros species, between 145 mm and 79 mm in the Ünlü species, and 143 mm to 78 mm in the KÇ-4. The yield values obtained according to the irrigation levels ranged from 39.3 to 44.7 t / ha in Westeros species, 36.2 to 43.1 t / ha in Ünlü, 32.5 to 41.2 t / ha in KÇ-4.

Seasonal plant water consumption (ET) values of melon species examined in the study ranged from 241 mm to 278 mm in Westeros species, between 246 mm and 284 mm in Ünlü species, and 239 mm to 277 mm in KÇ-4. In general, the yield in the varieties increased as the ET value increased. A positive relationship was found between ET and yield. The response of the melon species examined in the study to the water deficit was quite different. There is no significant loss in yield in the case of the Ünlü cultivar in which up to 40% deficit in irrigation water was applied. There was a higher yield loss compared to the other species in the KÇ-4 cultivar when a 20% water deficit was applied.

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