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WATER-YIELD RELATIONSHIP IN GRAFTED MELON

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Abstract

As in many plants, the water need of the plant cannot be met with the rainfall and irrigation of the plant to the root area causes significant increases in the yield in the cultivation of melon. There are many studies aiming to determine the amount of reduction that can be applied in irrigation water without causing any significant decrease in the quality and yield. However, the number of studies, if there is, in which a variety of melon is grafted on another kind of melon is extremely limited. In this article which is on irrigation, a grafted melon plant is discussed.

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

INTRODUCTION

In grafting, two plant cultivars with similar organic structure are combined into one plant with the use of different methods and they grow as a single plant. This is what is called grafting. Whereas the parts of the plants on the soil surface are called as scion for grafted plants, the root parts are called as rootstock (Yarşı & Rad, 2004).
The cultivation of grafted garden plants started in late 1920 when watermelon plants were grafted on the pumpkin rootstock in Korea and Japan (Yamakawa, 1983). Following the first experiments, the cultivation of such grafted plants gradually increased and the cultivation of grafted watermelon, cucumber and various *Solanaceae* plants have become more and more common either in greenhouses or fields (Kurata, 1992).
In recent years, the production of grafted plants has increased in many countries. In parallel with this increase, the intended use of grafted plants has also been diversified; for example, to increase plant growth and development, to control plant growth, to increase resistance to diseases caused by pathogens, to reduce viral, fungal and bacterial infections, to provide tolerance to abiotic stresses such as temperature, salinity, drought stress, to strengthen the root system, to increase nutrient and mineral intake (Rivero et al., 2003).
The first grafted seedling production for commercial purpose started with the production of tomato in 1998 in Turkey. In the following years, the number of grafted seedlings produced and the rate of production has increased hay by hay.
In the first years of the production of grafted seedlings, tomato seedlings were produced commonly, but in recent years the production of grafted watermelon seedlings reached significant amounts (Balkaya, 2013).
The production of grafted seedlings reached about 50 million units annually in Turkey when the year 2000 was considered. About 60% of this production is watermelon, 35% is tomato and 5% is eggplant (Abak et al., 2010).
In 2013, the number of companies producing grafted seedling reached 28, and the amount of seedling production reached approximately 120 million (Balkaya et al., 2015).
There are studies in the literature examining the adaptation of rootstock-cultivar (Salehi-Mohammadi et al., 2009; Haegi et al., 2013; Yıldız & Balkaya, 2016), nutrient intake in melons and other vegetables (Yarşı & Sarı., 2006), resistance to salinity stress (Colla et al., 2006; Orsine et al., 2013; Kiran et al., 2017), fusarium endurance (Crino et al., 2007;) and resistance to nematodes (Haunay & Halmasso,

1985; Rahman et al., 2002), endurance to drought, water use (Agelea & Cohenb, 2009).
In this study, Kırkağaç type 'Ünlü' melon varieties grafted on Ferro rootstock was examined.

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.
The irrigation water used was provided by pumping from the deep well in the research area.
As the plant material, non-grafted 'Ünlü' variety (*Cucumis melo* L.) and Kırkağaç type 'Ünlü' melon varieties grafted on Ferro rootstock were used.
Drip irrigation method was used as the irrigation method in the research.
Experimental treatments consisted of 4 irrigation levels applied to non-grafted 'Ünlü' variety and 'Ünlü' variety grafted on Ferro rootstock.
In the study, eight treatments consisting of a combination of two varieties and four levels of irrigation were discussed.
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 atm 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.
In the irrigation treatment 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.

$$d = \left(\frac{TK_{0-90} - MN_{0-90}}{100}\right) D * P$$

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 $hour^{-1}$; N = number of unit area drippers (1333 pcs/ha).

RESULTS AND DISCUSSIONS

The total amount of irrigation water applied to the treatments discussed in the study ranged from 67 mm to 117 mm in the grafted melon and from 79 mm to 145 mm in the 'Ünlü' variety.

In the study, yield values obtained according to irrigation levels ranged from 15.7 to 27.0 t ha^{-1} in grafted 'Ünlü' variety and between 29.6 and 40.3 t ha^{-1} in non-grafted 'Ünlü' (Figure 1).

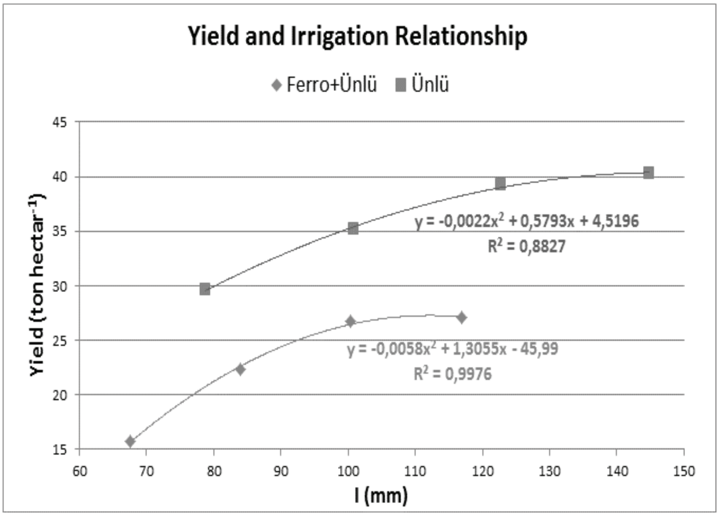

Figure 1. Change in yield due to the amount of irrigation water

Seasonal plant water consumption (ET) values in the melon varieties discussed in the study ranged from 191 mm to 225 mm in the grafted (Ferro + 'Ünlü') plants and ranged from 246 mm to 284 mm in the 'Ünlü' variety.

In general, as the ET value increased, the yield also increased in the plants and a positive correlation was found between ET and yield. However, although an equal amount of irrigation water was applied to grafted and non-grafted plants, ET values were found to be lower in the grafted plants than in the non-grafted plants. This may be due to the fact that the development of the grafted plants due to the rootstock adaptation is slower than the non-grafted plants.

Adaptation between rootstock and species is very important. The adaptation between the rootstock and the plant cultivar directly affects the intake of water and mineral elements necessary for optimal growth of the grafted plant. In other words, vascular discontinuity of the grafting joint may cause plant growth to slow down, and the plant may also cause physiological disorders, and consequently, the continuity of communication between plant cultivar and rootstock may be adversely affected.

The adverse effects of non-adaptation situation can be observed from the seedling stage and in later development periods, when the nutrient and water requirements of the plant increased and during the fruitage period (Martinez-Ballesta et al., 2010).

In the study, the coefficient of determination of the mathematical equation used for the estimation of yield based on ET was found to be (= 'Ünlü') R^2 = 0.990 for non-grafted plants, and R^2 = 0.977 for grafted plants (Ferro + 'Ünlü') (Figure 2). Kirnakand Dogan (2009) stated that the watermelon plant yields decreased as the ET value decreased. The determination coefficient for the mathematical equation which they used to calculate ET and yield relationship was R^2 = 0.99. Castellanos et al. (2016) reported that the levels of ET in the water vary between 356 and 472 mm in irrigations with different nitrogen levels and the yields obtained varied between 32.4 and 52.0 t ha^{-1}.

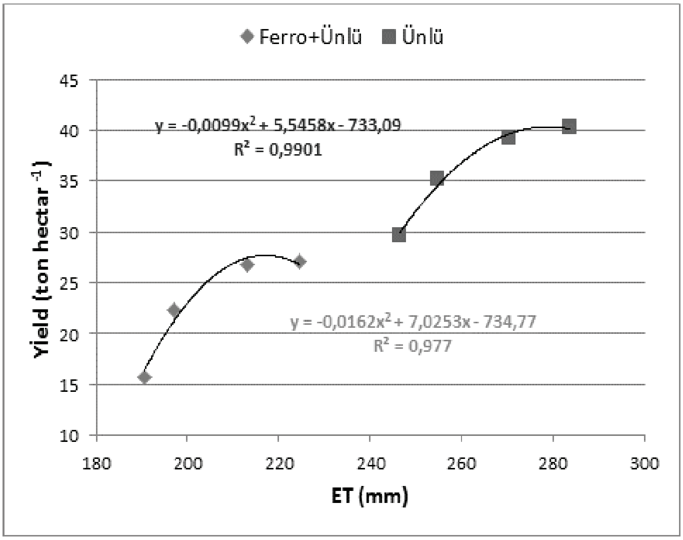

Figure 2. Plant water consumption (X = ET, mm) and yield relationship

In our study, the yield values of the grafted plants were found to be lower than the non-grafted plants. As a result of variance analysis conducted for the yield values, the effect of species effect on the fruit yield and the level of the irrigation level were found to be significant while the interaction of the species irrigation level was not significant. There were two statistics between the yield values of the species. The average yield obtained from the grafted 'Ünlü' species (36.0 t ha^{-1}) were found to be higher than the yield obtained from Ferro+'Ünlü' grafted species (22.9 t ha^{-1}). No statistically significant difference was found between the levels of I100 and I80 in terms of irrigation levels, and both treatments had higher yields than I60 and I40. The I60 treatment was found to be in group b with the second highest yield. The yield values of the I40 treatments were found to be the lowest in group c.
The effect of species effect on irrigation water use (IWUE), irrigation level effect and species level interaction were found statistically significant.
In the study, the efficacy of irrigation water use in non-grafted plants ('Ünlü') was higher than that of grafted (Fero + 'Ünlü') plants.
Whereas the irrigation level which has the lowest water use efficiency among the irrigation levels was I100, no significant difference was found among the other levels (I40, I60, I80).
There was no significant difference between the other levels (I40, I60, I80) and I100 with the lowest water usage efficiency average among the irrigation levels.
Out of the averages of species irrigation interaction, all irrigation levels of the grafted plants (Ferro+'Ünlü') (I100, I80, I60, I40) and non-grafted plants ('Ünlü'), I100 level IWUE was found to be in the lowest statistical group.
There was no statistically significant difference between I40 and I60 irrigation levels in the non-grafted plants with respect to IWUE, while

irrigation water use efficiency was higher than I80 and I100 levels at I40 level. In the case of non-grafted plants, in the I60 treatment, the IWUE value was found to be higher than I100.

In the study, the water use efficiencyin non-grafted plants was higher than that of grafted plants. In contrast to the results obtained in our study, San Bautista et al. (2011) reported that water use efficiency increased by 35% compared to non-grafted plants in double-grafted plants. Among the irrigation levels, the water use efficiency was the lowest in I40. The WUE averages of other irrigation levels were not statistically significant.

CONCLUSIONS

The total amount of irrigation water applied ranged from 67 mm to 117 mm in the grafted melon and from 79 mm to 145 mm in the 'Ünlü' series.

Seasonal plant water consumption (ET) values in grafted and non-grafted plants ranged from 191 mm to 225 mm in the grafted (Ferro + 'Ünlü') plants and ranged from 246 mm to 284 mm in the 'Ünlü' variety.

The average yield obtained from the grafted 'Ünlü' was found to be higher in the non-grafted plants compared to Ferro + 'Ünlü' grafted plant yield.

When the efficiency values f irrigation water are taken into consideration together with the yield; in cases where water is scarce and expensive, 40% irrigation water deficit is recommended in the cultivation of 'Ünlü' variety.

The recommended water deficit for 'Ünlü' variety grafted on the Ferro rootstock is 20%.

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