

BIOMETRIC CHARACTERISTICS OF 'CATHERINE SEL 1' PEACH CULTIVAR IN SEMIARID ENVIRONMENT

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Abstract

*In arid and semi-arid regions, irrigation application is mandatory for modern fruit growing, but the optimal irrigation application requires large amounts of water. In the context of global warming, water saving is a major objective. Therefore, deficit irrigation (DI) is an attractive alternative. The plant studied was thirteen years old 'Catherine Sel.1' peach trees. The trees were grafted on franc rootstock and planted in a 4 m x 3 m layout. Soil management was represented by clean cultivation both between tree rows and in the row. Fruit size and weight are important qualities and yield traits in peach (*Prunus persica* (L) Batsch), but the factors that influence fruit size and weight remain to be explored. The fruit biometrical characteristics was influenced by the irrigation regime, with the irrigated treatment with 100% AHI (T1) showing significantly ($P < 5\%$) higher differences versus T2 and T3. As with fruit biometrical characteristics, the fruit weight determined on the fruits of the studied treatments had the same trend. In this study, we investigated the impact of stress hydric on fruit size and weight at 'Catherine sel 1' peach cultivar in 2019-2020 period.*

*Keywords: climatic conditions, longitudinal diameter of fruit, *Prunus persica*.*

1. INTRODUCTION

Deficit irrigation (DI) has been proposed as a technique that irrigates the entire root zone with less than evapotranspiration needs and leads to reduced irrigation water use while maintaining farmers net profits (Hoffman et al., 1990). A decline in water availability for irrigation and the positive results obtained with DI in some fruit tree crops have renewed the interest in developing information on deficit irrigation for a variety of crops (FAO Report, 2002; Fereres and Soriano, 2007).

The concept of regulated deficit irrigation (RDI) was first proposed by Chalmers et al. (1981) and Mitchell and Chalmers (1982) to control vegetative growth in peach orchards, and they found that savings in irrigation water could be realized without reducing yield. Nevertheless, experiments with RDI have been successful in many fruit tree and nut species such as apricot (Ruiz-Sánchez et al., 2000), almond (Goldhamer et al., 2000), pistachio (Goldhamer and Beede, 2004). In Romania, peach is highly appreciated, but its favorability area is relatively restricted from the climate view point. It finds proper climate conditions in Dobrogea region, Romania, (winter temperatures not too low), more favorable than in other regions of the country.

The purpose of this study is to establish the impact of stress hydric on biometric characteristics and weight of the peach fruits.

2. MATERIALS AND METHODS

Climate and soil conditions. The studied orchard is located in village Agigea (44°05' Northern latitude and 28°37' Eastern longitude), Dobrogea region, Romania. This is a semi-arid region with a climatic water deficit (WD, as difference between the annual values of precipitation (P) and Penman-Monteith reference evapotranspiration (PM-ET_o) of about -405 mm on the Black Sea costal area (Paltineanu et al., 2007). The climate conditions at the experimental site are specific for a semiarid region, with a mean annual air temperature of 12.0°C, a mean annual precipitation amount of 425.8 mm and reference evapotranspiration totalizes 827.5 mm annually for 1980÷2009 period (Paltineanu et al., 2016a). Climatic data were recorded by automatic weather stations (WatchDog Weather Station 2000, Spectrum Technologies Inc., Aurora Illinois, USA and iMetos, IMT300, Pessl Instruments, Austria) by a 1-h step. These data were periodically transferred to a laptop and processed as diurnal means and used in calculations. The soil is a calcaro-calcic chernozem (*World Reference Base for Soil Resources, 2006) with a loamy texture and alkaline pH, a proper soil structure and high fertility in topsoil (0-60 cm). Land slop is between 1.0 and 3.0% and soil bulk density around 1.20 g cm⁻³. The normal tree rooting depth was 80 cm (Indreias, 1997), with field capacity and wilting point values of the soil at 0.300 and 0.125 cm³ cm⁻³, respectively.

Experimental design and irrigation application. The split-plot experiment described here is mono-factorial with irrigation strategy having three graduations. The peach tree (*Prunus persica* (L) Batsch) was selected for this study because is representative for this region. The biological material is representing by 'Catherine sel 1' cultivar omologated in 2004. The study was carried out during two years (2019÷2020). The fruit trees were planted in spring 2006, in a 4m x 3m layout. The studied plots comprised three adjacent fruit tree rows with the central row containing three trees for measurements and observations. The canopy shape was a classic vase and the soil management systems was clean cultivation both between tree rows and in the row. The irrigation regime consisted of the following treatments: T1- irrigated at 100% AHI (active humidity interval), T2- irrigated at 70% AHI and T3-control, non-irrigated treatment. The watering method used was drip irrigation. The dripper spacing was 0.6 m and the dripper discharge about 2.0 Lh⁻¹. The irrigation aplicated in June and August in 2019 and from April to August in 2020. We applied only four irrigations in 2019 with 20 mm in T1 and 10 mm in T2, totaling 80 mm in T1 and 40 mm in T2, respectively. However, there were six irrigation applications during the dryer period in 2020, each of 20 mm in T1 and 10 mm in T2, totaling 120 mm and 60 mm, respectively. No water was applied in T3.

Soil water content measurements. Soil water matric potential (SWP) was measured with Watermark resistance blocks (6450 Watermark Soil Moisture Sensor, Spectrum Technologies, Inc) installed for each fruit tree at four depths: 20, 40, 60 and 80 cm at a 150 cm distance from the tree trunk. The sensors were placed on the same vertical line at 45° angles below horizontal according to the method described by Paltineanu and Howse (1999). These data were recorded by WatchDog dataloggers (WatchDog Model 1650 Data Logger, Spectrum Technologies, Inc) and downloaded periodically by a laptop. The relationships between SWP measured with the Watermark sensors and

soil water content (SWC) measured gravimetrically were previously determined from field data (Paltineanu et al., 2011b); these relationships were then used to transform soil water matric potential readings into SWC values during the experiment.

Fruit determinations. Each year was tested average samples of 15 fruits/treatment. Fruit growth was monitored by measuring longitudinal and transversal fruit diameter and fruit height after harvest. The measurements were performed using a metric digital caliper (Insize Co., Ltd. China). The average weight of a fruit was determined by weighing 10 fruits/treatment and dividing by the number of weighed fruits. The weighing of the fruit was performed with a precision balance (Kern & Sohn GmbH, Germany). Fruit were harvested between the 23rd to the 24th of July in 2019 and from 27th to the 28th of July in 2020.

Data analyses

SPSS 14.0 software and Microsoft Office Excel were used for the analysis of variance and various calculations for fruit quality properties. Different letters in the graphs indicate significant differences for the probability ($P \leq 0.05$) according to Duncan's multiple range test.

3. RESULTS AND DISCUSSIONS

Climate conditions

During the growing season in the experimental period the mean yearly maximum and minimum air temperatures were 26.9 and 12.9°C, respectively, versus the long-term yearly means of 22.5 and 14.8°C. The mean annual air temperature was 19.9°C, versus 18.5°C for long-term, showing a trend of warming in the area. In the growing season, the mean annual precipitation amount was 159.2 mm, versus 224.2 mm for long-term, almost similar, and mean annual reference evapotranspiration was 735.9 mm, versus 661.5 mm for long-term, showing also a trend of dryness. ETo values were on average 145.0, 147.0 and 136.4 mm month⁻¹ during June, July and August, respectively. The average value of climatic water deficit (WD) in the growing season of the study period was -576.0 mm, versus -437.3 for long-term. The mean value of yearly and monthly climate data during the growing season in the experimental period is shown in the table 1 (a, b). The period of experiment (2017÷2020) was considered as a relatively normal period, showing however an aridization trend, with monthly temperature means of 22.7°C in June, 23.8°C in July and 24.6°C in August, respectively.

Table 1a. The mean value of annual climate data during the growing season in the 2017÷2020 experimental period versus the long-term, 1980 ÷ 2009, Agigea, Romania

Climatic data	Growing season	
	2017÷2020	1980÷ 2009
Mean air temperature, T_{med} (°C)	19.9	18.5
Mean maximum air temperature, T_{max} (°C)	26.9	22.5
Mean minimum air temperature, T_{min} (°C)	12.9	14.8
Precipitation, P (mm)	159.2	224.2
Reference evapotranspiration, PM-ET ₀ (mm)	735.9	661.5
Water Deficit/Water Excess, WD/WE (mm)	-576.0	-437.3

Table 1b. The mean value of monthly climate data during the growing season in the experimental period 2017÷2020, Agigea, Romania

Climatic data	Growing season					
	Apr	May	Jun	Jul	Aug	Sep
Mean air temperature, T_{med} (°C)	11.0	17.0	22.7	23.8	24.6	20.4
Mean maximum air temperature, T_{max} (°C)	18.1	23.6	29.7	30.9	32.0	27.3
Mean minimum air temperature, T_{min} (°C)	3.9	10.5	15.8	16.7	17.0	13.5
Precipitation, P (mm)	17.1	18.7	39.8	58.6	4.8	20.2
Reference evapotranspiration, PM-ET ₀ (mm)	95.2	129.0	145.0	147.0	136.4	83.3
Water Deficit/Water Excess, WD/WE (mm)	-78.2	-110.0	-105.0	-88.2	-132	-63.0

Soil water content (SWC) during in irrigation period

In 2019, the dynamics of soil water content (SWC) as a result of the four irrigation applications is shown in Figure 2a. It is noted that both in T1 and T2, the SWC values ranged from FC to MAD (management allowed deficit, mid-interval between FC and WP), except for the values from T2 treatment, last watering, which are found in the interval MAD and WP, with values close to MAD. The SWC values in T3 were between MAD and WP, due to the dry year.

In 2020, following the application of the six waterings the dynamics of soil water content is illustrated in Figure 2b. Thus, in the irrigated treatments, the SWC values oscillated in the range between FC and MAD. In T3, SWC values were to half interval between MAD and WP, with values approaching to WP at the end of vegetation period.

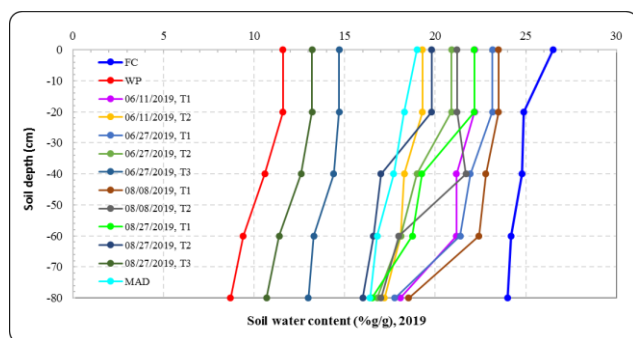


Figure 2a. Soil water content (SWC) profiles in the treatments studied Agigea village, Dobrogea, Romania-2019

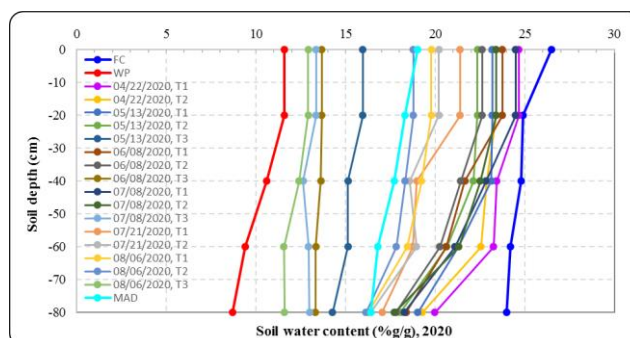


Figure 2b. Soil water content (SWC) profiles in the treatments studied Agigea village, Dobrogea, Romania-2020

Biometrical measurements and weight to peach fruits

After harvesting, the fruits of experience has been subjected to biometrical measurements and fruits weithing. The values presented represent average values of the two years of study. Thus, peach fruits had a longitudinal diameter of 52.0 mm to 81.0 mm. Fruits in the T1 treatment were much big, followed by the fruits from the T2 treatment. The smallest longitudinal diameter was found in T3 treatment. Figure 3 shows that there were significant differences between the treatments studied

on fruit's longitudinal diameter, as indicated by different letters according to the probability ($P \leq 0.05$) according to Duncan's multiple range test. As with fruit longitudinal diameter, the transversal diameter determined on the fruits of the studied treatments had the same trend. The highest value was obtained in T1 treatment, 70.3 mm and the lowest value in T3 treatment, 51.9 mm, respectively. Figure 4 shows significant differences, written with different letters, between the treatments studied regarding the fruits transversal diameter. The height of the fruits determined of the studied treatments had the same trend. The peach fruits had a height of 51.0 mm to 71.0 mm. Figure 5 shows significant differences between the treatments studied regarding the fruits height. As with fruit biometrical characteristics, the fruit weight determined on the fruits of the studied treatments had the same trend. The highest value was obtained in T1 treatment, 163.5 g and the lowest value in T3 treatment, 83.7 g, respectively. Figure 6 shows significant differences between the treatments studied regarding the fruits weight.

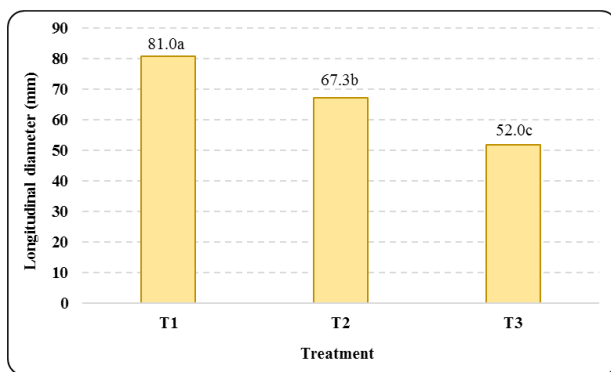


Figure 3. Longitudinal diameter (mm) of the peach fruits, 2019-2020

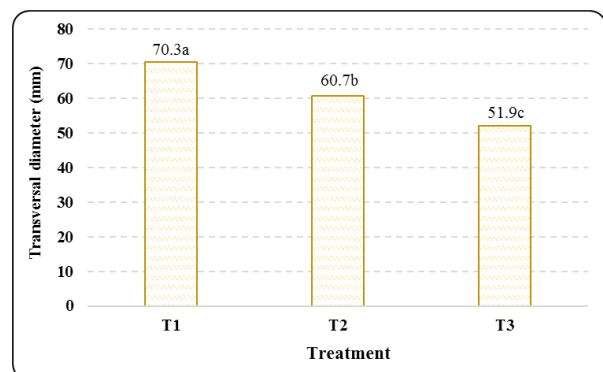


Figure 4. Transversal diameter (mm) of the peach fruits, 2019-2020

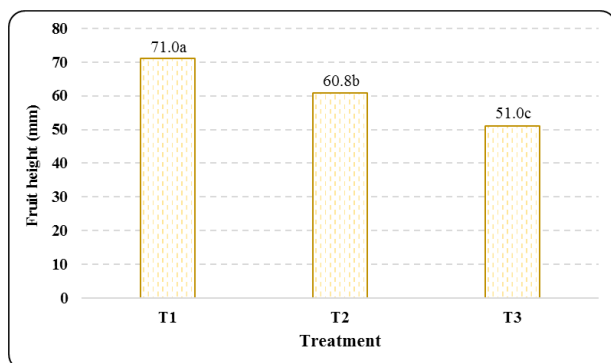


Figure 5. Fruit height (mm) of the peach fruits, 2019-2020

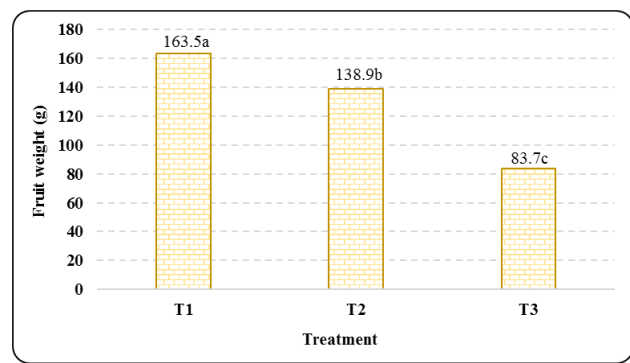


Figure 6. Fruit weight (g) of the peach fruits, 2019-2020

4. CONCLUSIONS

In the context of global warming, water saving is a major objective. Therefore, irrigation with hydric stress is an attractive alternative.

In the irrigated treatments, T1 and T2, the SWC values oscillated in the range between FC and MAD.

The fruit biometrical characteristics was influenced by the irrigation regime, with the irrigated treatment with 100% AHI (T1) showing significantly ($P < 5\%$) higher differences versus T2 and T3. As with fruit biometrical characteristics, the fruit weight determined on the fruits of the studied treatments had the same trend.

The study suggests that a moderate water stress can be profitable for enhancing key fruit biometrical characteristics.

5. ACKNOWLEDGEMENTS

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