Effect of Irrigation Levels on Fruit Quality of Picual Olive (Olea europaea L.) Cultivar

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Abstract: This study was carried out in two successive seasons (2004/2005 and 2005/2006) on the Picual olive (Olea europaea L.) cultivar grown in El-Maghara region in mid North Sinai Governorate. It was aimed to evaluate the effect of different Levels of irrigation on fruit quality of this cultivar. Trees were about 10 years old grown in sandy soil, planted at a spacing of 5m x 5m and the drip irrigation system was used. Three Levels of irrigation were used, i.e., 100% or 75% or 50% of the actual calculated needs of water requirements. Results indicated that fruit weight, volume, length, diameter and flesh thickness and moisture were increased under the 100% irrigation Level. Meanwhile the fruit oil content and water use efficiency were increased under the irrigation Level of 50% actual water needs. Acid value and saponification number were decreased by decreasing irrigation level. The effect of irrigation regime of 75% actual need gave intermediate values between 100% and 50% irrigation levels for studied parameters. It could be concluded that growing olive trees under water deficiency (50-75% of actual water requirements) may be employed to increase olive fruit oil content and water use efficiency and decrease acid value of olive oil.

Key words: Olive, Olea europaea L., Irrigation Levels, Fruit quality.

INTRODUCTION

Olive tree (Olea europaea L.) is one of fruit crops that tolerate drought and stress [21]. Olive tree under conditions of limited water supply may adapt to water stress and can perform well with less water [23]. However, the limited water availability in the Mediterranean ecosystems and the current predicted decrease of water resources are leading to the urgent need to reduce water use for irrigation in the arid and semi-arid regions. Prudent management of water is, therefore, essential for a viable olive industry. Since irrigation is essential to ensure optimal yield, it is imperative to develop sound and efficient irrigation methods for olive groves, with irrigation scheduling techniques based on the plant actual need and optimal use of water [10]. Several investigators studied the effect of irrigation regimes on olive trees [12,14,8,13,15,17,21]. In Egypt olive growers do not have a method or equation to calculate irrigation requirement, and they add excess of water.

The aim of this work was to evaluate the effect of irrigation Levels on the Picual olive fruit quality and water use efficiency under semi-arid conditions of mid North Sinai (El-Maghara region).

MATERIALS AND METHODS

This investigation was conducted in an olive orchard at El-Maghara Experimental Station, of the Desert Research Center located at El-Maghara region in mid North Sinai Governorate (latitude 30.43 N, longitude 33.19 E and 200 meter above sea level). The study was carried out in two successive seasons (2004/2005 and 2005/2006). The olive cultivar Picual (Olea europaea L.) used in this study was raised by semi hard wood cutting. The selected trees were of about 10 years old grown in sandy soil and planted at 5m x 5m apart. The drip irrigation system from wells of about 2548.4 ppm salinity (4.06 ds m) was used. The olive trees were irrigated every three days using drip nozzles. The water requirements for the experimental trees were calculated by the following equation: \( Iw = (ETo \times Kc \times Kr / (1-LR)) \times Pw / (Ea \times Ec) \), where:

- \( ETo \) is the reference evapotranspiration, as calculated by FAO Penman equation [3]. The weather variable needed for calculating ETo measured with an automatic weather station located next the experimental orchard.
- \( Kr \) = reduction coefficient according [14]; \( Kc \) = crop coefficient according to Allen et al. [9] (0.50, 0.50,
weight and fruit volume in green and black stage. Both fruit weight and fruit volume was estimated according to Snedecor and Statistical Analysis: Data were tabulated and statistically analyzed according to Snedecor and Cochran [22] and mean values were compared by Duncans multiple range test at 5% Duncan [4].

RESULTS AND DISCUSSION

Data presented in Tables (1 and 2) showed the effect of irrigation Levels on fruit quality of the Picual olive cultivar in green and black stages. Both fruit weight and fruit volume in green and black stage were significantly affected by irrigation Levels. The highest fruit weight and volume was recorded with 100% irrigation followed by 75% and then 50% which recorded the lowest values. Fruit weight and volume were higher in the green stage than in the black stage.

Concerning the effect of irrigation Levels on fruit dimensions it was noticed that 100% irrigation gave the highest fruit length and diameter followed by the irrigation levels of 75% and 50%. The differences between irrigation levels of 100% and 75% were insignificant for fruit diameter in both seasons and fruit length in the first season only. Both fruit length and diameter were higher in the green stage than in the black stage.

Regarding the effect of irrigation Levels on flesh thickness and fruit moisture data in Tables (1 and 2) indicated that irrigation Level of 100% produced the highest flesh thickness and fruit moisture followed by irrigation Level of 75%. Meanwhile the lowest flesh thickness and fruit moisture was obtained by the irrigation regime of 50%. Flesh thickness of the black fruit was higher than that of green fruit. In the contrary, fruit moisture was higher at green stage than at black stage. These results are in harmony with those reported by Faci et al. [9] who mentioned that the weight of 100 olive fruits increased with increasing the irrigation water amount. Also, Grattan et al. [11] found that fruit size increased with increasing applied water to olive tree. Moreover, Aurora Go´mez-Rico et al. [6] mentioned that the fresh olive fruit weight was consistently higher under the irrigation treatment than under rain-fed conditions which contributed to the higher production yield observed in the irrigated olive orchard. Similary, D’Andria et al. [6] found that fruit weight at harvest of Frantoio and Leccino olive cultivars showed a linear enhancement according to the irrigation water volume. Meanwhile, Aganchich, et al. [1] reported that the individual fruit weight and dimensions were generally greater under partial rootzone drying (PRD) than under irrigation with 100% of the crop evapotranspiration. On the other side, Melgar et al. [13] reported that the irrigation regimes did not cause significant differences in fruit size. Deficit irrigation strongly reduced vegetative growth, but only slightly reduced the final fruit volume of olive cv. Arbequina [13].

In addition to oil fruit content it was noticed that irrigation Level of 50% gave the highest percentage of oil fruit content followed by 75% (Figs. 1 and 2). Meanwhile, the lowest oil fruit content was recorded with the irrigation Level of 100%. This was noticed in both seasons of study and the differences between the three Levels of irrigation were significant. There was an adverse correlation between oil fruit content and irrigation Levels as the oil content increased by
Table 1: Effect of irrigation Levels on Picual olive fruit characteristics at the green stage in 2004/2005 and 2005/2006 seasons.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Fruit weight (g)</td>
<td>Fruit volume (cm³)</td>
<td>Fruit length (cm)</td>
</tr>
<tr>
<td>100%</td>
<td>7.07 A</td>
<td>6.93 A</td>
</tr>
<tr>
<td>75%</td>
<td>7.00 A</td>
<td>6.83 B</td>
</tr>
<tr>
<td>50%</td>
<td>6.41 B</td>
<td>6.28 C</td>
</tr>
</tbody>
</table>

Values followed by the same letter(s) in each column are not statistically different at 5% level of probability.

Table 2: Effect of irrigation Levels on Picual olive fruit characteristics at the black stage in 2004/2005 and 2005/2006 seasons.

<table>
<thead>
<tr>
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<tbody>
<tr>
<td>Fruit weight (g)</td>
<td>Fruit volume (cm³)</td>
<td>Fruit length (cm)</td>
</tr>
<tr>
<td>100%</td>
<td>9.04 A</td>
<td>9.30 A</td>
</tr>
<tr>
<td>75%</td>
<td>9.00 A</td>
<td>8.94 A</td>
</tr>
<tr>
<td>50%</td>
<td>8.32 B</td>
<td>8.27 B</td>
</tr>
</tbody>
</table>

Values followed by the same letter(s) in each column are not statistically different at 5% level of probability.

Fig. 1: Effect of irrigation Levels on oil content (%) of picual olive fruit at green stage in 2004/2005 and 2005/2006 seasons.

Fig. 2: Effect of irrigation Levels on oil content (%) in picual olive fruit at black stage in 2004/2005 and 2005/2006 seasons.
decreasing water addition. Under irrigation Level of 50% the fruit oil content increased about 10% comparing to using 100% irrigation, so growing olive trees under water deficient conditions helps the growers to increase their income by saving 50% of water and increasing the amount of extracted oil. In general, oil fruit content was higher in black stage than in green stage.

Concerning acid value and saponification number (Figs. 3 and 4), they decreased significantly by decreasing irrigation water, as the highest values of both acid value and saponification number were achieved with the irrigation Levels of 100% followed by 75% and 50%. So decreasing irrigation water from 100% to 50% of the requirements gave a good effect on lowering acid value which combined with increasing oil quality as well as obtaining a high market value, where there is a negative relationship between acid value and marketing price of olive oil. In this respect, Lavee and Schachtel \(^{(15)}\) found that the effect of irrigation on reducing the oil content in the fruit was the strongest in cultivar Muthasan and considerably less in cultivars Sori and Barnea. Moreover Alegre et al. \(^{(2)}\) added that 25% Etc evaportranspiration had more flesh oil percentage and seemed to have higher values in the maturity index for olive tree. Also they indicated that olive oil yield per tree follows a second order relationship with increased applied water. Motilva et al. \(^{(16)}\) demonstrated that oil production of olive tree (expressed as kg oil by 100 kg of olive fruit) increased significantly with decreasing water supply. Also, Aganchich et al. \(^{(1)}\) found that the olive oil contents were generally greater under partial rootzone drying (PRD) than under the irrigation with 100% of the crop evapotranspiration. Dag et al. \(^{(5)}\) reported that increased irrigation water quantity increased the free acidity level of the oil. Also, they concluded that the harvested fruits from irrigated olive Souri trees demonstrated an apparent sensitivity to mechanical wounding that subsequently led to increased free acidity, increased peroxide level and decreased total phenol content in oil. On the other hand, the oil acidity and peroxide value have no significant differences throughout irrigation treatments. Moreover, Patumi et al. \(^{(20)}\) concluded that irrigation did not affect fruit oil content of olive. Similary, Aurora et al. \(^{(4)}\) revealed that the irrigation treatment apparently did not affect the oil accumulation in the Cornicabra fruit.

Regarding water use efficiency (WUE) Fig. (5) showed that the lowest quantity of irrigation water (50%) recorded the highest WUE followed by 75%. Meanwhile the lowest WUE was achieved with the trees which received their complete water requirement (100%). So in this case we can save about 1249.89 to 1396.68 m\(^3\) of water per feddan when we use 50% of irrigation water. Also, when using 75% of irrigation water the growers can save about 634.95 to 698.35 M\(^3\) of water per feddan.

**Fig. 3: Effect of irrigation Levels on acid value of picual olive oil in 2004/2005 and 2005/2006 seasons.**

In general, when Picual olive trees were planted under deficiency of water (50 to 75% of its actual water requirements) they may be show adverse effects on some fruit characteristics such as fruit weight, volume, dimensions and flesh thickness, while they show beneficial effects on fruit oil content which were increased significantly when the trees received 50% or 75% of their water requirements. Under these conditions, it could be recommended to grow oil olive cultivars for getting higher fruit oil content and lower acid value as well as saving about 50% of water requirements and improving water use efficiency (WUE) which might increase the net profit for the olive growers under drought or water deficient conditions.
Fig. 4: Effect of irrigation Levels on saponification number of picual olive oil in 2004/2005 and 2005/2006 seasons.

Fig. 5: Effect of irrigation Levels on water use efficiency (WUE) of picual olive cultivar in 2004/2005 and 2005/2006 seasons.

REFERENCES


