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Effect of irrigation on fruit quality of table olives (*Olea europaea*), cultivar 'Ascolana tenera'

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Abstract This trial was carried out to study the relationship between irrigation and vegetative and productive activity and fruit quality of table olives (*Olea europaea*), cultivar 'Ascolana tenera'. Irrigation every 15 days, with c. 0.4 m^3/tree at each irrigation, from the end of June to mid September, induced higher leaf surface area, photosynthesis, and transpiration during the entire growing period compared to the control. This led to an overall positive effect on total production per tree. Fruit weight, volume, and pulp/pit ratio all increased. Water availability influenced cell division more than cell expansion. Fruit shape was not influenced. Irrigation had no substantial delaying effect on ripening. With irrigation, pulp water content increased, and firmness and fruit sugar content decreased slightly, but after preservation in brine, pulp water content, and the sensory characteristics of the olives (flavour, texture, and detachment of the pulp from the pit) from irrigated and non-irrigated olives were not substantially different. Irrigation improved the commercial value of the fruit by increasing size, higher pulp/pit ratio, and more intense fruit colouring.

Keywords *Olea europaea*; table olives; water stress; photosynthesis; vegetative activity; fruit characteristics

INTRODUCTION

The olive (*Olea europaea* L.) is a tree species with high resistance to drought (Dettori et al. 1989; Natali et al. 1991). However, irrigation allows productivity to increase in olive growing areas where rainfall is scarce. Water availability increases shoot growth, flowering, fruit set, and reduces fruit drop and alternate bearing (Baratta et al. 1986; Michelakis & Vougioucalou 1988; Lavee et al. 1990; Michelakis 1990; Özyilmaz & Özkara 1990; Solé Riera 1990; Chartzoulakis 1992). A good water supply is also very important for obtaining satisfactory fruit size of table olives, which is a factor strictly correlated to the commercial value of the product (Milella & Dettori 1986; Michelakis & Vougioucalou 1988; Dettori et al. 1989; Gatto 1989; Lavee et al. 1990; Özyilmaz & Özkara 1990).

Many trials have been carried out to determine the influence of irrigation on the vegetative and productive activity of olive, but little information is available on the relationship between irrigation and fruit quality of table olives (Baratta et al. 1985; Brighigna et al. 1989; Dettori et al. 1989).

In addition to the effects of irrigation on vegetative and productive activity, this trial was carried out to study the effects on drupe characteristics before and after processing for green table olive production.

MATERIALS AND METHODS

The trial was carried out in 1992–93 in Central Italy (Calvi dell'Umbria—Terni) in a 15-year-old olive orchard, located c. 300 m above sea level, planted in clay loam soil (Table 1). In this area summer environmental conditions frequently produce water stress in non-irrigated olive trees. The cultivar was 'Ascolana tenera', trained to the palmette system and spaced 5 × 5 m (each tree covered c. 9 m^2 ground area). Olive trees with similar vegetative and productive characteristics were selected. Fifteen were irrigated with the furrow method (water

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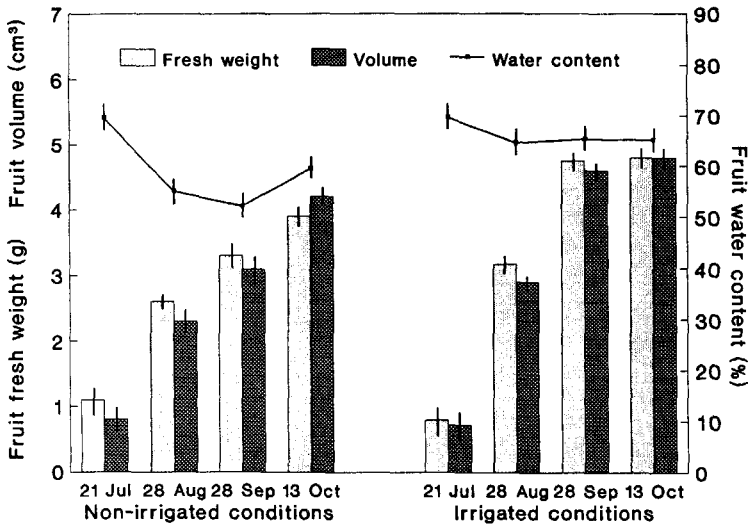

Fig. 4 Effect of irrigation on table olive (*Olea europaea*) fruit fresh weight, volume, and water content. Bars represent the standard errors of the means.

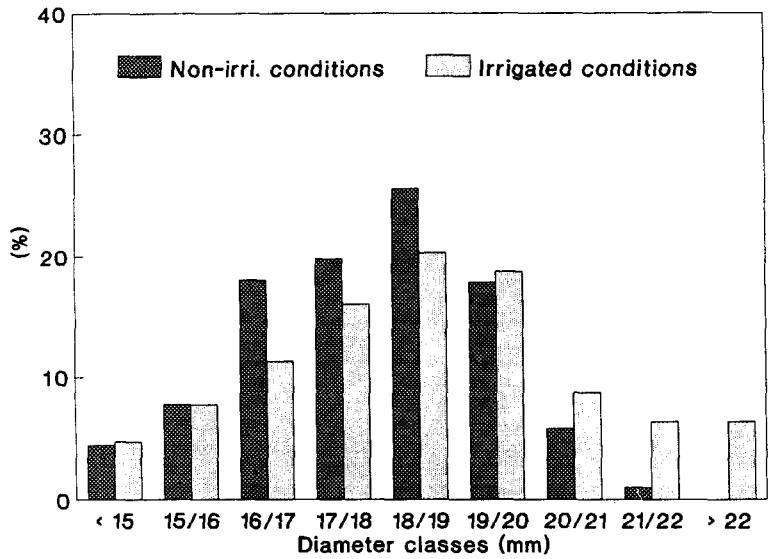

Fig. 5 Effect of irrigation on percentage of marketable table olive (*Olea europaea*) fruits in relation to their size at harvest (13 Oct).

non-irrigated conditions showed a fair recovery (Fig. 4). In non-irrigated plants, the fruit water content dramatically decreased in August and September and increased in October but remained at a lower level with respect to the irrigated plants. The higher water content of the olives was mostly the result of the higher pulp-pit ratio (Table 3).

Fruit characteristics

At harvest the fruit weight was 4.8 and 3.9 g for irrigated and non-irrigated plants, respectively. Irrigation increased the percentage of larger marketable fruit but with a wider size distribution (Fig. 5).

The fresh pit weight, fruit shape, fruit drop, and detachment force were not influenced by treatment (Table 3). The firmness and the content of reducing sugars of the pulp were lower in irrigated conditions (Table 4). The oil content with respect to the pulp dry matter was not significantly influenced by treatment, so drupe oil content was higher with water treatment.

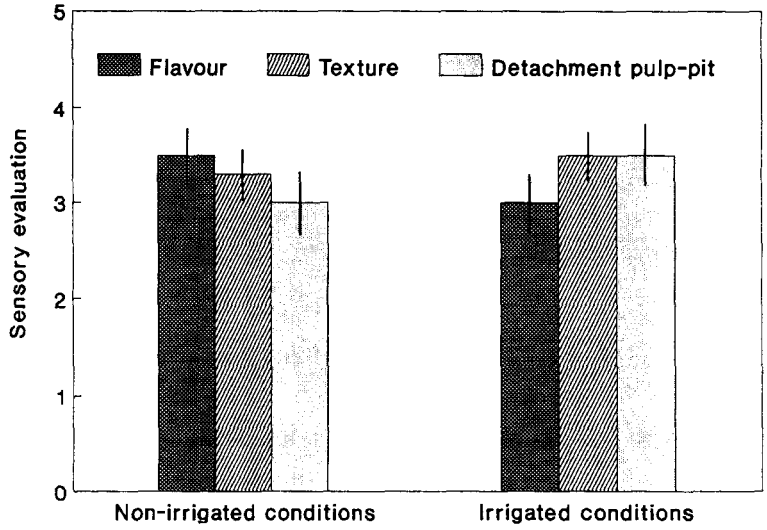

Fig. 6 Effect of irrigation on sensory characteristics of table olive (*Olea europaea*) fruit preserved in brine. Bars represent the standard errors of the means.

The histo-anatomical observations of mesocarp sections indicated that the cells of fruits of irrigated plants were only slightly bigger than these of non-irrigated plants.

The constant availability of water in the soil significantly increased the yield per tree by 30% (27.3 and 35.1 kg for non-irrigated and irrigated plants, respectively).

The olive mesocarp of irrigated trees, after preservation in brine, had a lower content of reducing sugars and a higher chlorophyll content than olives of non-irrigated trees (Table 5). There were no substantial differences between treatments in the water mesocarp content and in the sensory characteristics of the olives (Fig. 6)—the olives of both treatments showed easy detachment of pit from pulp, compact pulp, good flavour, and pleasant taste.

DISCUSSION

Irrigation induced greater shoot growth, total leaf surface area, photosynthesis, and transpiration

Table 3 Effect of irrigation on fruit characteristics of table olive (*Olea europaea*) at harvest (13 Oct). (In each column, means followed by the same letter are not significantly different at $P \leq 0.05$.) (FW = fresh weight.)

Treatment	Pulp/pit (FW/FW)	Pit FW (g)	Longitudinal/ transverse diameter	Detachment force (N)
Non-irrigated conditions	4.3 a	0.74 a	1.37 a	6.3 a
Irrigated conditions	5.4 b	0.75 a	1.35 a	6.5 a

Table 4 Effect of irrigation on mesocarp characteristics of table olive (*Olea europaea*) at harvest (13 Oct). (In each column, means followed by the same letter are not significantly different at $P \leq 0.05$.) (DW = dry weight.)

Treatment	Water (%)	Firmness (g)	Reducing sugars (% DW)	Starch (% DW)	Oil (% DW)	Cell diameter (μm)
Non-irrigated conditions	70.2 a	385 b	6.5 b	0.70 a	53.2 a	56 a
Irrigated conditions	73.8 b	341 a	5.0 a	0.94 a	54.3 a	60 a

Table 5 Effect of irrigation on mesocarp characteristics of table olive (*Olea europaea*) after preservation in brine (13 Oct). (In each column, means followed by the same letter are not significantly different at $P \leq 0.05$.) (DW = dry weight.)

Treatment	H_2O (%)	Sugars (% DW)	Reducing starch (% DW)	Total chlorophyll (% DW)
Non-irrigated conditions	72.3 a	3.1 b	0.69 a	0.011 a
Irrigated conditions	72.6 a	1.6 a	0.70 a	0.020 b

during the entire growing period. This led to an overall positive effect on total production per tree. However, further experimentation would be necessary to produce definitive information on the effect of irrigation on olive fruit production.

Irrigation did not influence fruit shape, but increased fruit weight, volume, and pulp/pit ratio. Larger fruit size was primarily the result of a larger number of cells and the positive effect of water availability on cell division rather than cell expansion. The difference in weight was mostly because of the fruit water content. Evidently water stress, besides decreasing plant activity, causes a drop in fruit water content and fruit growth, which is only partially reversible after removing the stress.

Irrigation had no substantial delaying effect on ripening.

With irrigation, pulp water content increased and firmness decreased slightly, but after preservation in brine, pulp water content and sensory characteristics of olives (flavour, texture, and detachment of the pulp from the pit) were not substantially different for irrigated and non-irrigated olives. Less sugar content and higher oil content of olives of irrigated trees could indicate greater metabolic activity (Brighigna et al. 1989). The low sugar content can be unfavourable to fermentation. Hence, it could be useful to add fermentable sugar to the brine to produce good lactic fermentation, which is important for good fruit storage.

In conclusion, in Mediterranean areas where rainfall in the summer is scarce, irrigation improves the commercial value of olive fruit by increasing size, higher pulp/pit ratio, and more intense fruit colouring.

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