EFFECTS OF IRRIGATION ON YIELD COMPONENTS AND QUALITY OF WALNUT CULTIVAR 'CHANDLER'

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Abstract: *In Italy walnut cultivation is mainly concentrated in Campania region, where traditional and new specialized orchards coexist and international cultivars are utilized for the new plantations. The growth and productivity of the international, high yielding cultivar 'Chandler' grown in the dry summer conditions of Naples province has been examined during a two year irrigation trial. Three treatments were applied: an un-irrigated control and two different levels of water supply, corresponding respectively to the restitution of 50 and 100% ET_0 by means of a drip irrigation system. Plant growth and nut and kernel weight increased at the highest irrigation volume, while nut fall at ripening was more concentrated in the un-irrigated control. The percentage of defected nuts was higher in condition of limited water availability. The restitution of 50% ET_0 assured satisfactory levels of production and saving of irrigation water.*

Key words: walnut, cultivar *'Chandler'*, irrigation

INTRODUCTION

Walnuts are important dry fruits in the world and the most important producers are China, USA, Iran, Turkey and France. In Italy, walnut cultivation is mainly concentrated in Campania region, often mixed with others fruit crops, as hazelnut, peach or apricot. At present some new specialised orchard are growing up and foreign cultivars, as Chandler, Hartley and Lara, are utilised for the new plantations [5]. Notwithstanding, an appropriate orchard management in this area is still lacking in particular for some agronomic treatments as the irrigation.

In general, the management of irrigation in this area is still based on a simplified soil water balance [3]. Furthermore, it has recently been observed that under conditions of low nitrogen and high water availability the oil in the kernel showed high amounts of some sterols, tocopherol such as saturated fatty acids, and oleic acid, confirming the influence of irrigation not only on growth and yield components but also on qualitative traits of the nuts [6].

Thus, in order to better understand the effects of irrigation on growth, productivity and some qualitative traits of walnut grown in areas characterised by dry summer and high temperature, common climatic conditions in the south of Italy, a trial has been carried out during 2007-2008 in Naples province, on a cv. Chandler orchard, comparing three different drop irrigation treatments.

MATERIAL AND METHOD

The observations on the effect of irrigation on growth, yield, technological and qualitative traits of the nuts were carried out in an orchard located in Naple province (Italy), from 2007 to 2008. The trees were thirteen to fourteen-years old plants cv. Sorrento, re-grafted with cv. 'Chandler' in 2002. The plants were spaced 8 x 8 m and trained to a free vase. The orchard was not irrigated until the beginning of the trial in 2007. Three treatments were applied: an un-irrigated control and two water levels, corresponding to the restitution of 50% and 100% ET_0. The treatments were arranged in a complete randomized block design, with two replications. Four plants per plot were used for the experimental observations and measurements.

Water was supplied every three-four days by means of a drip irrigation system. Starting from the middle of June three different volumes of irrigation were applied, corresponding respectively to the restitution of 0, 50 and 100% ET_0, calculated on the basis of Blaney-Criddle method [8].

Vegetative growth (trunk circumference) ***and yield*** (kg/plant) were measured annually and trunk cross-sectional area (AST) and yield efficiency (YE) were calculated. The nuts were harvested both year two times at a distance of about ten days, depending on time of natural drop.

Nut traits (nut and kernel weight, width, thickness and height and shell weight) ***and defected nuts*** were recorded on subsamples of 200 nuts for each treatment and year. Nut shape ((width + thickness/2)/ height) and seed/nut ratio were calculated according to Cristofori et al. [4]. Dry weight was determined by heating at 103 ± 2°C to constant weight.

Oil content in the kernel was determined by the Soxhlet method using light petroleum ether (boiling point 40-60°C). A 10 g of finely crushed kernels was placed in a cellulose thimble and extracted with 200 mL of petroleum ether for 6 h in a Soxhlet apparatus. After extraction the solvent was evaporated and the residual oil was weighed. A fraction of crashed kernels was used to determine the moisture content as previous reported.

Meteorological parameters, such as temperature and rainfall were also registered in the close meteorological station of Marigliano (NA).

For the statistical analysis all the collected data were processed by means of the analysis of variance, using the procedure SYSTAT MGLH [7], considering volume of irrigation, year and their interaction. Least significant difference (LSD p=0.05) for the comparison of the means was calculated.

RESULTS AND DISCUSSIONS

Climatic conditions and water applied during the experiment

The weather conditions from 2007 to 2008 are summarized in table 1. In both years July was the critical month, without or with very low rainfall, the highest average value of maximum temperature and a high daily evaporative demand. The irrigation period, which started at the middle of June, was characterized by a higher amount of rainfall in 2007 than in 2008, but mainly concentrated in May and September.

Yield components and nut quality

Water supply showed a positive effect on yield components (table 2). Yield increased as a response to water supply and the highest production of nuts was

obtained to 50% ET_0 for both years (table 2). A similar response was observed in other studies carried out on hazelnut [1,2]. The highest yield efficiency was observed in plants treated to 50% ET_0 with values on average of 0.66 and 1.07 in 2007 and 2008, respectively. The dynamic of nut drop was similar in irrigated and un-irrigated trees (table 2).

Table 1

Evaporation (*Blaney and Criddle*), rainfall, duration of the irrigation season and water applied during the two years of the experiment

Year	ET (mm) M-S	Rain (mm) M-S	Rain (mm) Ir	Ir duration	% ET_0 Water applied (mm) 0	50	100
2007	495.7	156.0	31.4	73	-	143.2	286.4
2008	511.4	119.6	36.6	82	-	152.8	305.6
M-S : May-September Ir: irrigation season							

Table 2

Vegetative growth and yield components variates as a response to irrigation (Significance * P≤ 0.05; ** P ≤ 0.01; *** P ≤ 0.001).

Year	% ET_0	Production (kg $plant^{-1}$)	YE (kg cm^{2-1})	1st harvest (%) (03 Oct)
2007	**0**	13.4	0.052	57.25
	50	23.5	0.066	56.15
	100	13.8	0.034	62.30
2008	**0**	24.5	0.086	27.51
	50	39.1	0.107	22.78
	100	27.0	0.064	34.25
Effects				
% ET_0 (a)		*	n.s.	n.s.
Year (b)		***	*	***
a x b		n.s.	n.s.	n.s.

Nut and kernel weights were slightly greater in irrigated than in control plants, showing a positive effects of water supply and year (table 3). Contrariwise, shell weight showed the lowest value in 50% ET_0 thesis. The differences of percent kernel observed among irrigation treatments were statistically significant (table 3), and nuts collected in thesis 100% ET_0 showed values of about 47% in both years of the trial, versus values of 43% obtained in the un-irrigated control.

With the exception of mould, the incidence of defected nuts was influenced by irrigation and for poor fill also by year (table 4). In general, the incidence of defected nuts was higher in the un-irrigated plants than in the irrigated ones, and blank nuts were observed only in the control. High incidence of partially poor fill nuts was revealed for all thesis (fig. 1).

Table 3

Nut traits as affected by irrigation
(Significance * P≤ 0.05; ** P ≤ 0.01; *** P ≤ 0.001).

Year	% ET_0	Nut weight (g)	Kernel weight (g)	Shell weight (g)	Nut shape	Kernel %
2007	**0**	12.29	5.53	6.90	0.84	43.22
	50	12.14	5.61	6.53	0.86	46.03
	100	13.29	6.25	7.04	0.83	46.77
2008	**0**	10.84	4.91	5.93	0.81	43.11
	50	10.90	5.05	5.85	0.82	46.22
	100	11.70	5.63	6.07	0.80	47.69
Effects						
% ET_0 (a)		**	***	*	*	**
Year (b)		***	***	***	***	n.s.
a x b		n.s.	n.s.	n.s.	n.s.	n.s.

Table 4

Defected nuts as affected by irrigation
(Significance * P≤ 0.05; ** P ≤ 0.01; *** P ≤ 0.001).

Year	% ET_0	Mould (%)	Poor fill (%)	Blank (%)
2007	**0**	5.0	45.0	2.5
	50	-	40.0	-
	100	2.5	35.0	-
2008	**0**	2.5	30.0	5.0
	50	-	17.5	-
	100	5	12.5	-
Effects				
% ET_0 (a)		n.s.	*	*
Year (b)		n.s.	*	n.s.
a x b		n.s.	n.s.	n.s.

Fig. 1. In 2007 an high incidence of poor fill kernels was observed

In particular the incidence of poor fill was significantly affected by irrigation with the highest values (45%) observed in the un-irrigated control during 2007. Just during the first year of the experiment poor fill nuts were detected in higher incidence on all thesis probably because of the high temperature and dryness in July and August.

The oil content in the kernels ranged from 62.5% to 65%, depending on irrigation volume and year (fig. 2). Significantly higher oil content was detected in nuts collected in 2007. Contrariwise, irrigation volume had only a low, not statistically significant influence on the oil content in the kernel (fig. 2).

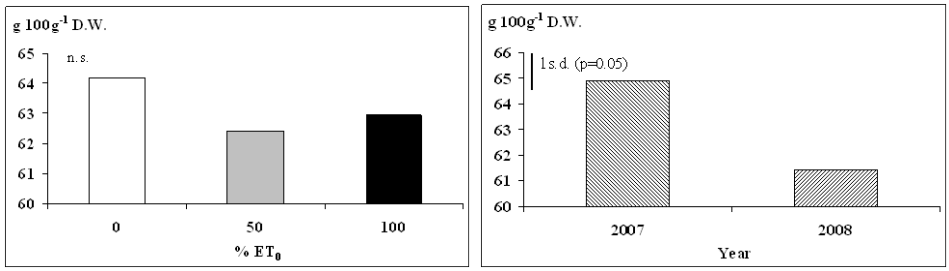

Fig. 2. Oil content in the kernel as affected by irrigation (left) and year (right)

CONCLUSIONS

In the environmental conditions of the trial, the recorded rainfall was not sufficient to assure good growth and production of adult and re-grafted plants of the cultivar 'Chandler'. Irrigation consistently improved plant performances in particular for nut traits and for the low incidence of defected nuts. The restitution of 50% ET_0 assured the best growth and production of the tested cultivar.

The irrigation strategy based on the estimation of crop evapotranspiration and water balance allowed a simple management strategy and good quantitative and qualitative results on walnut when compared to rainfed conditions.

ACKNOWLEDGEMENT

This work was supported by the Italian Ministry of Agriculture and Forestry Policy (MIPAAF 2005 D.M. 212/7303 'FRU.MED.', subproject VA.FRU.SE.ME., publication n° 73).

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