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Impact of water deficit on physiological parameters, bioactive content and antioxidant activity of three olive cultivars

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ABSTRACT

We studied changes in morphology, sclerophylly, chlorophyll photosynthetic parameters and total phenol contents in leaves of three olive (*Olea europaea L.*) cultivars; Oueslati, Jarboui and Meski which grew under water deficit conditions. Our results showed significant differences in trichome and stomatal densities, area of the leaf and relative surface of stomatal pores. The photosynthetic parameters Fv/Fm, ΦPSII and ETR were negatively affected by the water deficit in these three varieties. The total phenolic and flavonoid contents increased in all cultivars, with Oueslati showing the highest values. The Oueslati variety could be considered as the most drought-tolerant compared to Jarboui and Meski. Therefore we believe this cultivar is the most suitable for cultivation in semi-arid environments.

1. Introduction

The Olive tree (*Olea europaea* L.) is a member of the Oleaceae family which is native to tropical and subtropical regions (Nilsen, 1995). It is tolerant to drought and salinity (Bongi and Paliotti, 1994). Its ability to adapt to water availability results from modifications of morphological, anatomical and physiological parameters of the leaves, which are very sensitive to environmental changes (Chartzoulakis et al., 1999; Tognetti et al., 2004; Marchi et al., 2008). The leaves are rich in secondary metabolites, i.e. secoiridoid derivatives such as oleuropein and oleacein, endowed with hypoglycemic and hypotensive properties (Gonzalez et al., 1992).

Olive trees occur all over Tunisia and grow traditionally under drought conditions (Gimenez et al., 1997). However, some dissimilarities between cultivars have been reported with respect to their response to drought conditions (Fernandez et al., 1997; Connor and Fereres, 2005).

It is very useful to evaluate the morphological and physiological traits implied in drought resistance to assist the breeding process. In the present study, we have used the Meski-, Oueslati- and Jarboui olive cultivars which are common to Tunisia. The 'Meski' cultivar is known for its drought-sensitivity (Ennajeh et al., 2006, 2008). However little is known about the drought tolerance of the Oueslati and Jarboui cultivars which are yet of great economic importance. Therefore, we evaluated the response of these olive trees to drought conditions so as to verify which are the cultivars that best resist to this type of stress. Hence, morphological and physiological aspects of the leaves were compared before and after water deficit under semi-controlled conditions.

2. Methodology

2.1. Site description and plant material

Tunisian olive cultivars (*Olea europaea* L. cv. Meski (North), cv. Jarboui (Teboursok) and cv. Oueslati (Kairouan)) were the subject of this study (Fig. 1). Two-year-old plants were grown in 10-dm^3 pots in greenhouse conditions at the olive institute of Sousse (Sahel, Tunisia; 35°N,10°E). Pots were filled with a mixture of sandy soil and manure (2:1, v/v), having a pH of 7.6, a field capacity of 35% and permanent wilting point of 15%. Throughout the experiment the temperature and humidity were respectively 25–32 °C and 55–65%. Six plants from each variety were irrigated once a week to field capacity and used as controls. Another six plants from each cultivar were stressed by withholding water in May and June,

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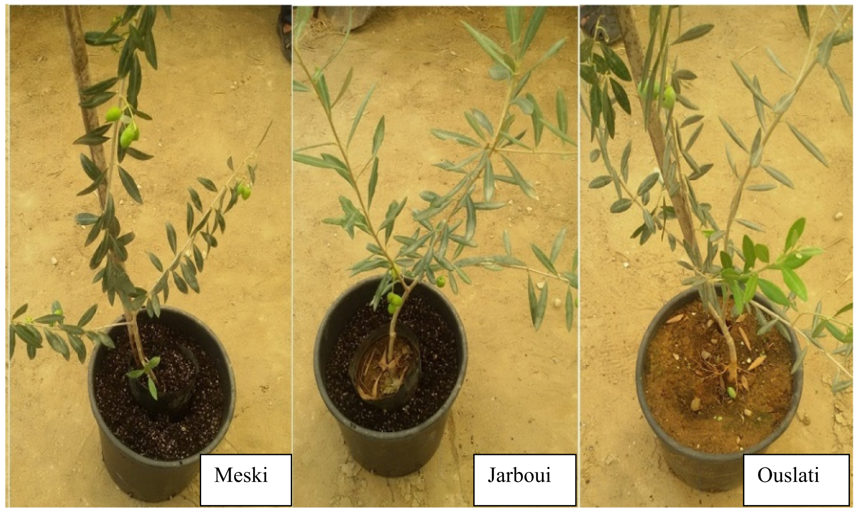

Fig. 1. The three olive Tunisian cultivars.

until the water content of the soil almost reached about 6.5% (wilting point). A factorial design of the experiment comprised six treatments of three cultivars and two watering's (Fig. 2).

2.2. Stomatal and trichome densities

The stomatal (SD) and trichome densities (TD) on the abaxial leaf-surface were evaluated according to Meinder and Mansfield (1968). Observations were performed using a light microscope (MCX300; Micros, Vienna, Austria) equipped with a camera (CAM2800-XP 3.0; Micros) connected to a personal computer. The relative surface of the stomatal pore was calculated as follows:

$$RS = (a.b)/4.DS.10^{-4}$$

RS = relative%surface of the pores

a and b = length and the width of the stomatal opening (μm), respectively.

DS = number of stomata/mm.

2.3. Leaf morphology and sclerophylly

Ten mature leaves obtained from each cultivar were gathered. The leaf area (LA) of the leaves was measured with Windias software. The fresh mass (FM), turgid mass (TM), and dry mass (DM) of the leaves were also measured (Ennajeh et al., 2008). Additionally, the sclerophylly indices were calculated: the specific leaf area (SLA) was determined as the ratio of LA to DM of individual leaves, and the leaf density (D) was calculated as $D = (DM/FM) \times 1000$.

2.4. Measurement of chlorophyll fluorescence parameters

The parameters were measured as reported by Ranjbarfordoei et al. (2006). Six flag leaves from each cultivar were selected to measure chlorophyll fluorescence parameters. Dark adaptation period for all the measurements was about 30 min, and chlorophyll fluorescence

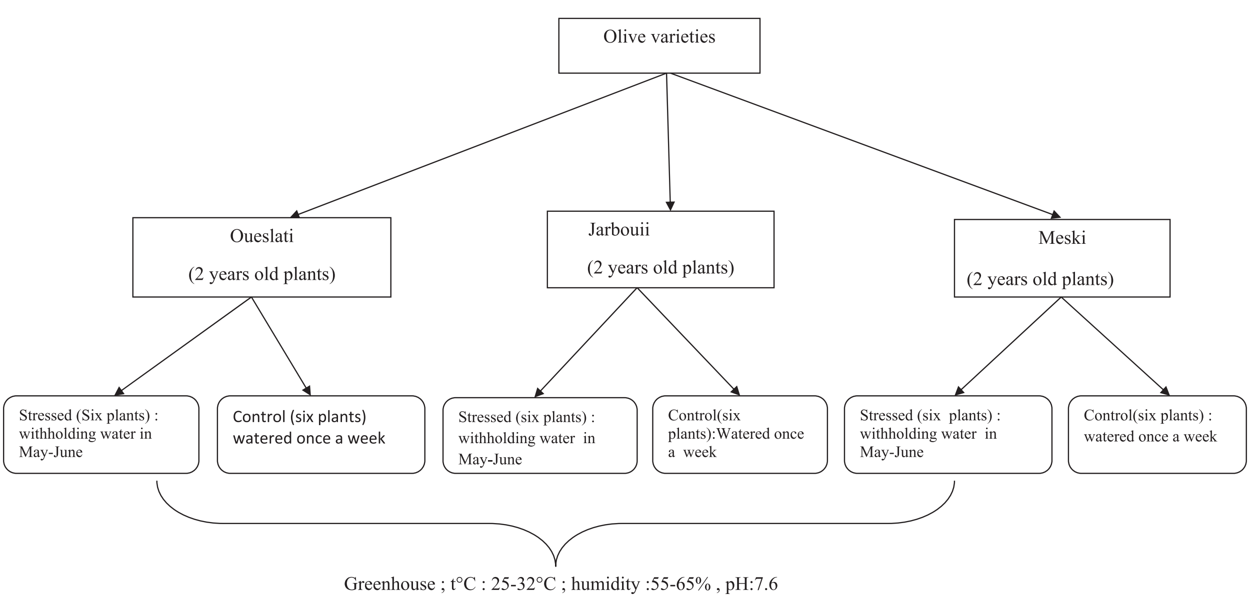

Fig. 2. Flow diagram of the experimental procedure.