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# Effect of alleviating products with different mode of action on physiology and yield of olive under drought

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ABSTRACT

Two years old self-rooted Koroneiki olive trees (*Olea europaea* L.) were subjected to two irrigation regimes, i.e. the fully irrigated and the severely water stressed trees, while they were treated with three alleviating products of different mode of action. The products used were the osmolyte glycine betaine, the antioxidant Ambiol and the heat and irradiance reflecting kaolin clay particles. The effects of product application and water regime on leaf characteristics, shoot and root growth, photosynthesis, leaf compatible solids (carbohydrates) concentration and yield were evaluated. All products applied, exhibited significant alleviating action, based on the relative alleviation index. Irrigated trees exhibited greater growth than drought stressed ones, while the ameliorating products maintained the water content of the leaves under drought conditions and resulted in lower leaf tissue density. On the other hand carbon assimilation rate, stomatal conductance and intrinsic water use efficiency were significantly reduced under drought stress, while the opposite stood for intercellular $CO_2$. Drought stress resulted in elevated sucrose leaf concentration, while the application of Ambiol increased stachyose concentration and that of glycine betaine did the same with the mannitol concentration. Among the alleviating products tested in this experiment Ambiol and glycine betaine had a significant positive effect on leaf water content, photosynthesis and yield under both drought and well irrigated conditions.

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## 1. Introduction

The olive tree (*Olea europaea* L.) is an ever-green tree native in the semi-arid Mediterranean climate. Mediterranean type climate is characterized by low rainfall, excessive heat load and high daily irradiance levels during the growing season (Chaves et al., 2002; Diaz-Espejo et al., 2007). These environmental conditions greatly influence the growth and productivity of crop plants, as they all exhibit additive and interactive effects on plant physiology (Griffin et al., 2004; Diaz-Espejo et al., 2007).

Plants have adapted through various mechanisms in order to withstand drought stress (Diaz-Espejo et al., 2007). One of the very early responses to water scarcity is stomatal closure, which aims on reducing transpiration losses of water (Fernandez et al., 1997). Due to the common diffusion pathways of both carbon dioxide and water, stomatal closure not only reduces water loss but also carbon assimilation (Sharkey and Schrader, 2006). Osmotic adjustment, by the synthesis and accumulation in the cytosol or vacuole of osmotically active compounds (such as proline, glycine betaine, polyols, etc.), is another mechanism, which the plant uses in order to withstand drought stress (Mäkelä et al., 1998a).

Low leaf water content, due to limited water availability, is very often associated with increased production of reactive oxygen species (ROS), which damage cellular structures and macromolecules (Navarri-Izzo and Rascio, 1999). The production of such ROS is inevitable since the leaf cannot dissipate the excess light energy, with its stomata closed, and the over-reduction status leads to electron transfer to oxygen and production of ROS (Navarri-Izzo and Rascio, 1999).

High temperatures on the other hand can also inhibit growth and development (Griffin et al., 2004). As stomata close, evaporative cooling is inhibited, resulting in elevated leaf temperature (Sharkey and Schrader, 2006). Temperatures above 35 °C, common to Mediterranean type climates during summer months, significantly decrease Rubisco activity and thereby limiting photosynthesis (Chaves et al., 2002; Griffin et al., 2004; Sharkey and Schrader, 2006).

The olive tree undergoes significant stress when water availability is low and high temperatures and irradiance levels occur during the growing season (Angelopoulos et al., 1996). Various products have been used to ameliorate the negative effects of water stress in plants, aiming at different physiological or biochemical functions.

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