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Photosynthetical activity modelisation of olive trees growing under drought conditions

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Predicting photosynthetic production in olive trees is a key feature in managing the effect of climate change on arid areas. Functional-structural plant modelling is a promising tool for achieving this goal. We used a photosynthetic sub-model that accounted for water and temperature stress and implemented it into LIGNUM model. We then conducted an experiment to validate the model at the leaf level using olive trees (*Olea europaea*) grown under various climatic condition. Then, we simulated photosynthetic production of three static olive tree models aged 1, 2, and 3 years. Results revealed a good fit between observed and predicted photosynthesis, with coefficient of determination (R^2) values of 0.94 and 0.93 for Chemlali and Zarrazi cultivars, respectively. These results showed that the impact of water stress on photosynthetic production was marginal.

The olive tree (*Olea europaea* L.) is one of the most characteristic tree species in Mediterranean agro-ecosystems, and is well adapted to severe drought[1]. However, predicting the responses of olive trees to different climate scenarios remains a key challenge for agriculture. The empirical approach cannot predict novel or non-analog responses. Thus, models based on that approach are less effective when it comes to predicting crop responses to climate change[2–4]. Furthermore, the application of empirical models in regions characterized by diverse climatic conditions is often criticized. Hence, an approach is needed that: makes future projections that include novel responses is robust to generalization across regions takes account of horticultural techniques. The process-based approach can meet the first two conditions but is insufficient to model the effects of cultivation techniques such as pruning[5–7]. The functional-structural plant model, which combines process-based models with three-dimensional plant structure, can meet all three requirements[5]. This approach allows us to simulate the canopy architecture in the environment and incorporate the effect of pruning techniques, sunlight, and carbon allocation[8–12].

Photosynthetic production is a key feature for developing an accurate functional-structural plant model, particularly in environments with an inconsistent climate[13]. As a first step, developing a static functional-structural plant model is a conservative method of predicting photosynthesis production, without the effects of other growth-related aspects, such as carbon allocation and dynamic growth patterns. The model can also explore the performance of the functional-structural tree model in response to temperature-stressed and water-stressed environments. This is the first time this model has been applied to arid land[14]. Hence, photosynthesis predictions must be consistent and accurate across a wide range of temperatures, soil-moistures, vapour pressure deficits, and light intensities. This study aimed to implement a static olive tree model into LIGNUM. We tested the validity of a parameterized Farquhar photosynthesis sub-model coupled with the LIGNUM sky model on young olive trees grown under controlled climatic conditions. In addition, we simulated the annual photosynthetic production of three different ages of static olive tree models (aged 1, 2,and 3-years-old).

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