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Leaf area estimation by considering leaf dimensions in olive tree

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ABSTRACT

Area (LA) estimation, based on individual leaf dimensions [length (L) and width (W)], was addressed in olive tree. Ten cultivars exposed to two watering regimes (irrigated versus rainfed) under field conditions were examined. Petiole length, leaf L, W, perimeter, base and apex angles, four shape indicators, together with LA were digitally assessed in fully-expanded leaves (480 leaves per treatment; 9.600 leaves in total). Large cultivar differences mainly in leaf size and secondarily in leaf shape were apparent. All parameters were affected by water deficit, but to a cultivar dependent extent. Leaf size was generally reduced by lack of irrigation in most cultivars. LA was estimated with higher accuracy by employing L alone, as compared to W alone, in eight cultivars. LA estimation was always improved by considering both L and W simultaneously, as compared to a single dimension. By studying each cultivar individually, LA estimation was within accepted limits ($0.71 \leq R^2 \leq 0.92$) in nine cultivars, whereas in the tenth one a moderate R^2 (0.63) was obtained. The accuracy of this estimation was not improved by pooling the data of all cultivars. Watering did not significantly affect the relation between estimated and measured LA. The obtained data indicate that a universal LA estimation model for olive tree carries the pitfall of moderate accuracy, owing only to cultivar differences, since environmental effects were trivial.

1. Introduction

Olive tree is one of the most extensively cultivated fruit crops worldwide, while its cultivation is best suited to the Mediterranean-type climate (Sofo et al., 2008; Abdallah et al., 2018). Consequently, most (> 95%) of the production is located in the Mediterranean basin, a region where water often becomes a limiting factor (Sofo et al., 2008; Abdallah et al., 2018). A great variety of olive tree cultivars are under cultivation depending on both the use (edible olives and/ or olive oil) and local microclimate (Bartolini, 2008; Sebastiani and Busconi, 2017).

For the optimization of the cultivation, monitoring of crop growth and productivity, which requires successive leaf area (LA) measurements, is necessary (Fiorani and Schurr, 2012; Fiorani et al., 2012). It is well established that LA is pivotal for light interception, photosynthesis and transpiration, thus being a key parameter in several agronomic and physiological studies (Giday et al., 2013; Fanourakis et al., 2015, 2016a; de Oliveira Silva et al., 2018). However, LA measurement of several leaves carries the dual pitfall of both being time-consuming and invasive (Fiorani and Schurr, 2012; Fiorani et al., 2012). To overcome this bottleneck in LA assessment, LA is noninvasively estimated in situ through its allometric relation with length (L) and width (W) of the leaf in several crops (Antunes et al., 2008; Pompelli et al., 2012; Keramatlou et al., 2015). Despite the economic importance of olive tree as a major fruit crop, measurements of LA are mostly still performed destructively and to our knowledge no specific model for non-invasive estimation has been established. Under this background, this study aims to develop a mathematical model for estimating LA by using leaf dimensions in olive tree. This goal was undertaken by taking into account both the diversity

Abbreviations: L, leaf length; LA, leaf area; W, leaf width

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