Laboratory for Research Methods in Quantitative Remote Sensing

Crown segmentation effects on the relation between field-measured assimilation and chlorophyll fluorescence quantified from high-spatial resolution hyperspectral imagery

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Introduction

Rising attention is given to solar-induced chlorophyll fluorescence (SIF) for global monitoring of vegetation physiology. Several environmental factors, including light, water and nutrients may limit plant photosynthetic capacity. In this regard, recent studies have focused on the feasibility of chlorophyll fluorescence as a proxy linked to photosynthesis and therefore as a potential indicator of early stress. Other studies make progress on the assessment of crop physiological status using narrow hyperspectral indices retrieved from hyperspectral reflectance imagery. In this work, the solar induced chlorophyll fluorescence and the physiology-related hyperspectral indices were evaluated in order to understand their ability to track photosynthetic activity as a function of the different within-crown scene components and background effects when using diverse automatic object-based tree crown detection methods.

Materials and Methods

The Experiment was carried out in July and August 2015 in an almond orchard managed with regulated deficit irrigation (RDI) treatments and different nitrogen and rainfed conditions (RC) in Córdoba (Spain). A total of 3 airborne campaigns and field physiological datasets were collected at the leaf level on summer of 2015 using a very high-resolution (20 cm) hyperspectral camera.

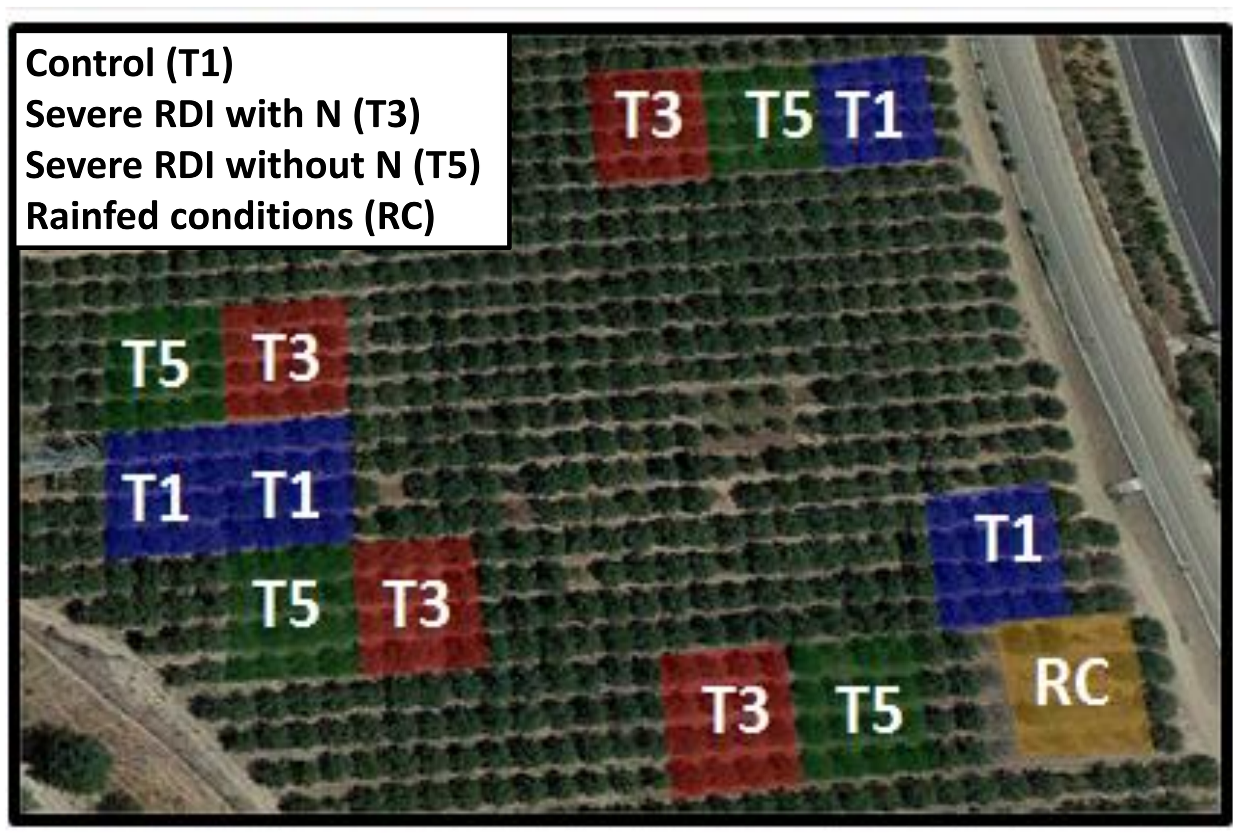

Fig. 1. Overview of the almond orchard site managed and treatment description.

Field measurements

Assimilation rate (A)

Stomatal conductance (Gs)

Headwall	Hyper VNIR
FWHM	6.40 nm
Spectral resolution	20 cm/pixel
Spectral band	260 bands
Spectral domain:	480-800 nm

Table 1. Hyperspectral camera configuration.

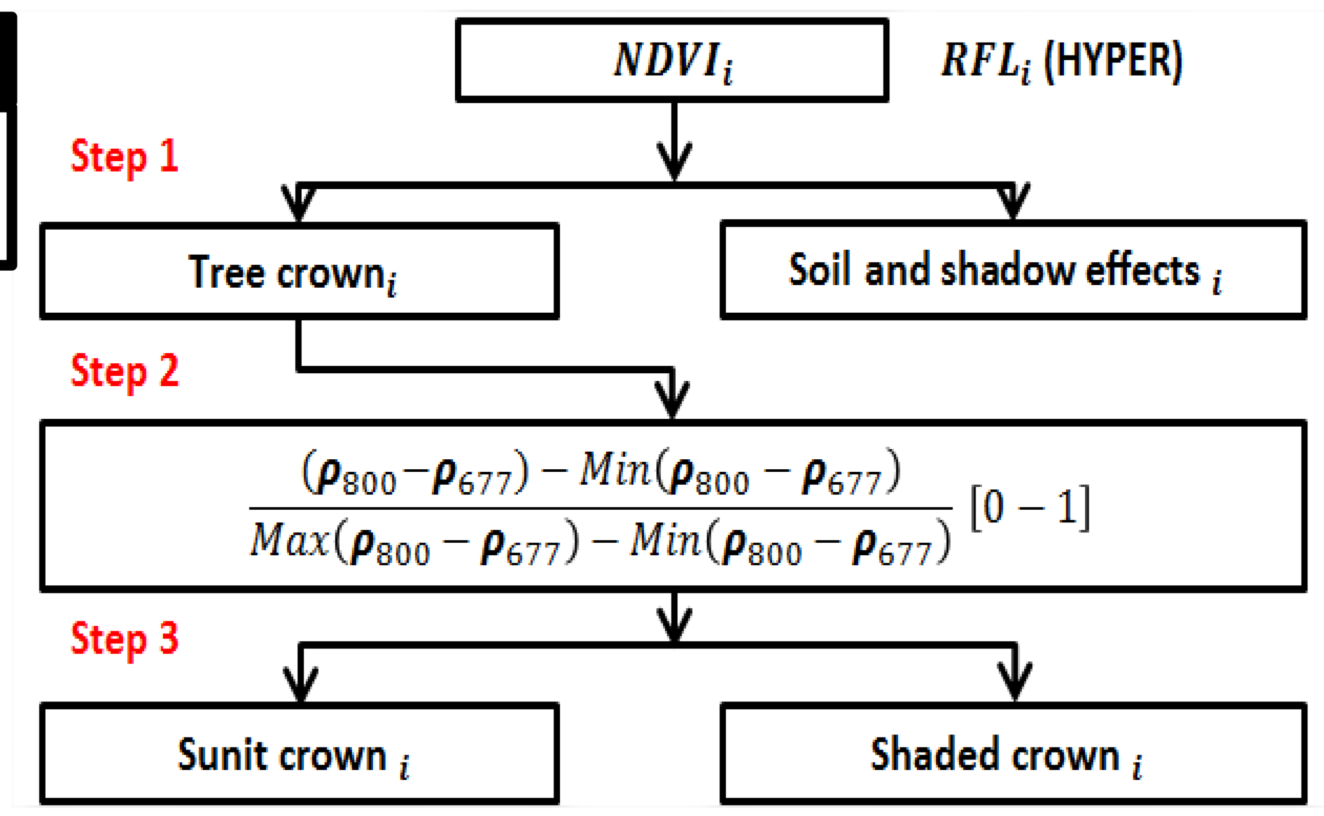

Fig. 2. Automatic object-based tree crown detection algorithm based on watershed segmentation.

Results

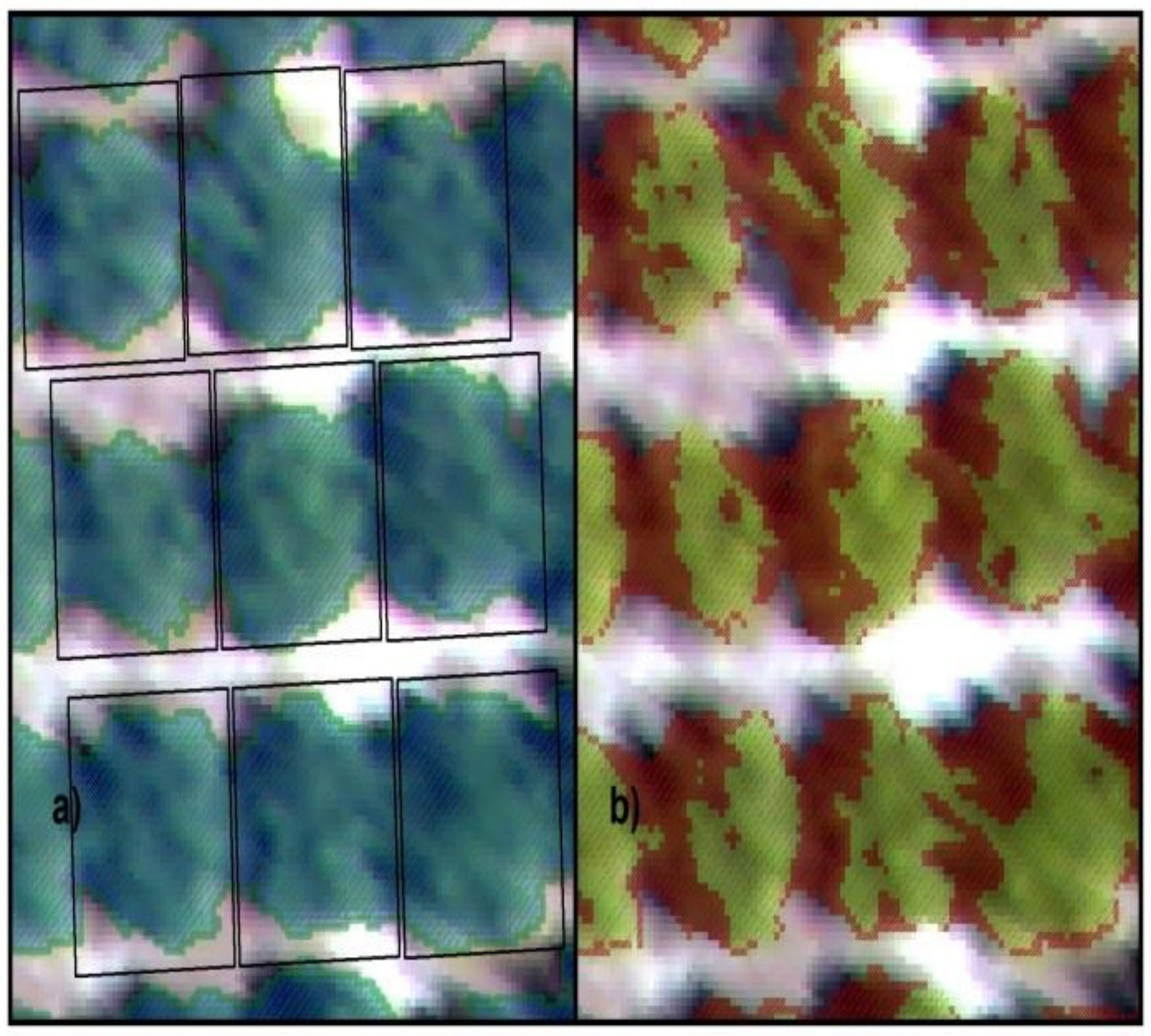

Fig. 3. View of the crown segmentation retrieved during the first flight.

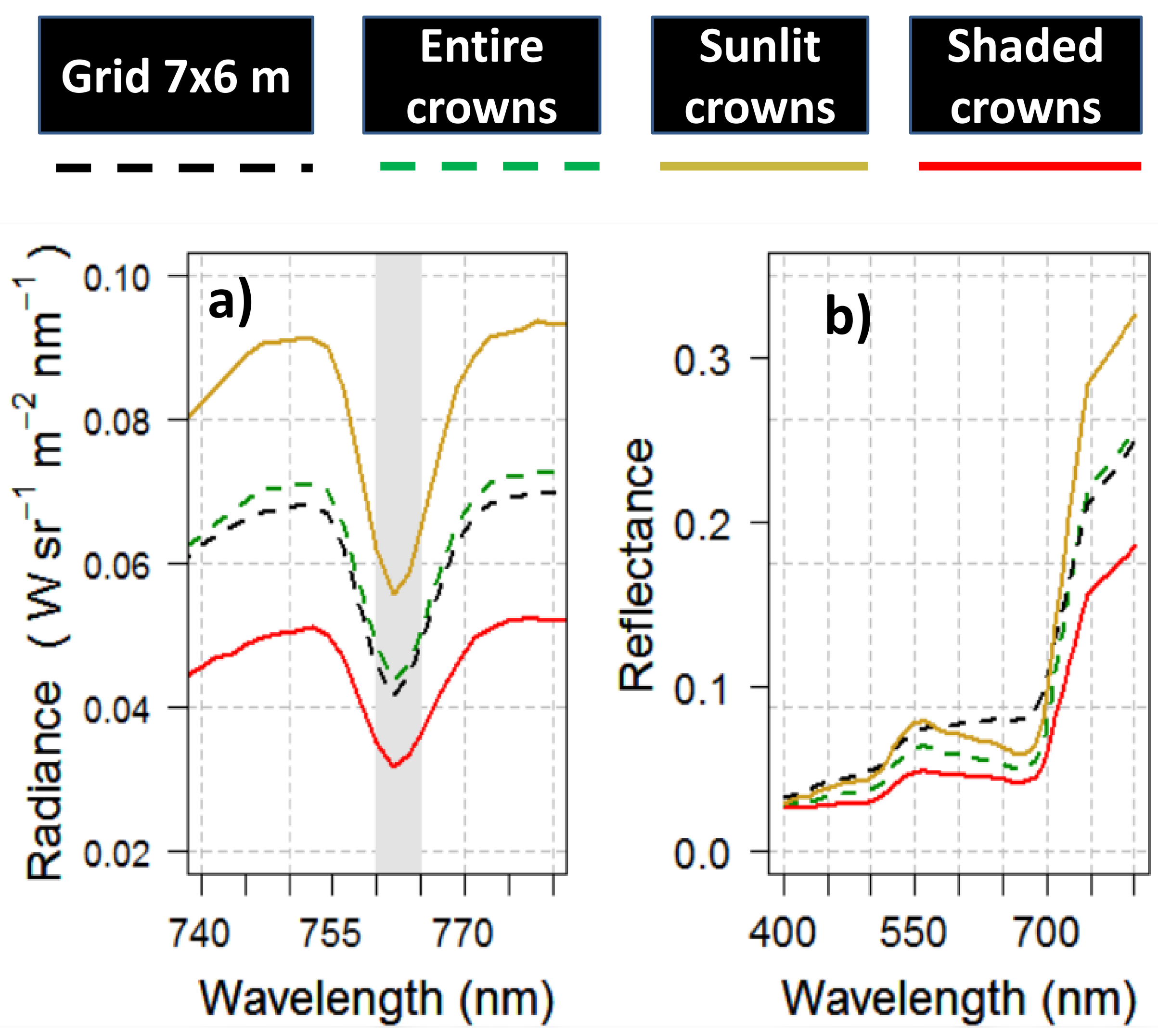

Fig. 4 Radiance (a) and reflectance spectra (b) retrieved from the hyperspectral imagery.

	Grid	Entire crowns	Sunlit crowns	Shaded crowns
SIF	**0.64**	**0.80**	**0.83**	**0.66**
GM1	0.50	0.52	0.55	0.49
PRI	0.19	0.58	0.61	0.51

Table 2. R^2 between A vs SIF and narrow-band indices for each segmentation method.

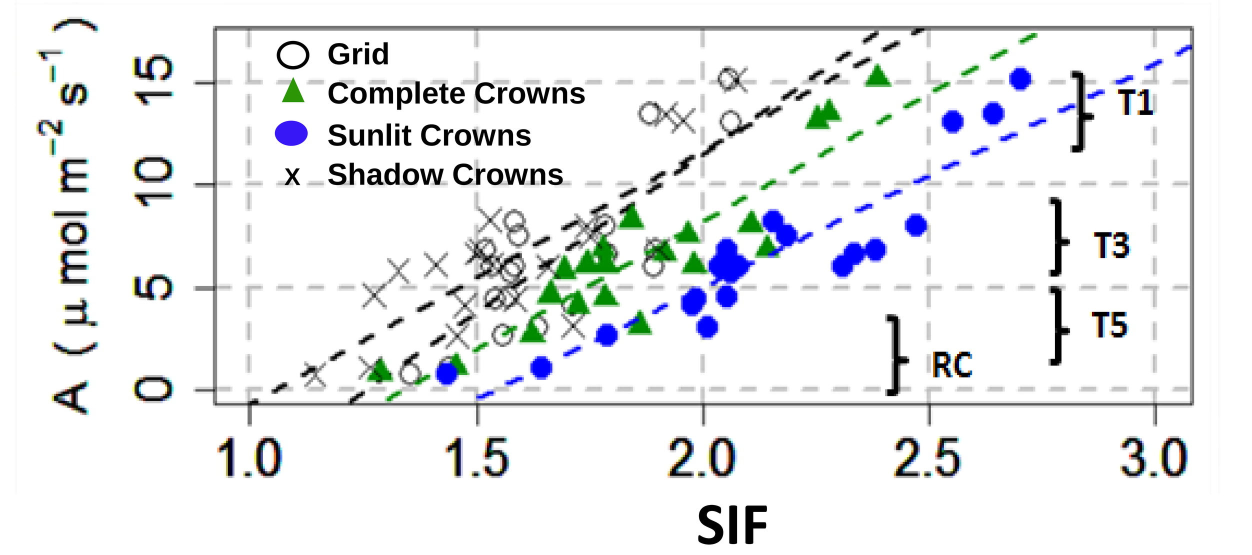

Fig. 5 Relationships obtained between assimilation (A) and SIF for each segmentation method conducted.

Conclusions

This study demonstrates that SIF and narrow-band physiological indices improve their capacity to track the photosynthetic activity of trees using sunlit crown pixels extracted trough segmentation methods. It is also highlighted the feasibility of using high resolution hyperspectral imagery to track photosynthesis in the context of precision agriculture.

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