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Implementing a novel hyperspectral based LAI predicting index for fruit orchards

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The accurate prediction of leaf area index (LAI) using remote sensing techniques is essential as it is one of the major input factors in radiative transfer canopy models. Moreover, LAI is an indispensable parameter in many other research fields.

The principle of the present study is that spectral features which are invariant at leaf level, even under varying biochemical properties, and variant at canopy level, could provide a good measure for canopy structure, with LAI being one of the major elements determining canopy structure. Based on this assumption, an index combining wavelengths 1250 nm and 1050 nm, referred to as Leaf Area Index Predicting Index or LAIPI (standardized form: sLAIPI), was selected from a hyperspectral temporal dataset of apple leaves. The invariance of this index at leaf level was then validated on hyperspectral datasets of peach and orange leaves.

Results have proven that the index remained relatively stable independent of phenology or species. The application of this index on a canopy level dataset of citrus and peach trial resulted in large differences in index values, indicating the potential of this index to estimate LAI. LAI values estimated by means of the newly developed (s)LAIPI resulted in excellent agreements with in-situ measured LAI values, with determination coefficients (R^2) of 0.83. The newly developed (s)LAIPI was also found

to perform outstanding at high LAI values (LAI = 11) compared to well-known LAI related indices such as NDVI (saturation at LAI = 5) and MCARI2 (saturation at LAI = 8). Moreover, the (s)LAIPI index was found to be independent of changing chlorophyll content, which makes this index also a valuable tool to more accurately extract chlorophyll content independent of the LAI.