Physical modelling of Nikon Coolpix camera RGB responses for application in non-destructive leaf chlorophyll imaging

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ABSTRACT

Chlorophyll content is an important characteristic of plant leaves and a critical parameter for modelling purposes and the scaling up from leaf to canopy level. Leaf colour is an indicator of chlorophyll content, closely coupled with the nutrient status of a plant more specifically nitrogen content. Therefore leaf colour is an important indicator of processes impacting on leaf chlorophyll and nitrogen metabolism. This typically holds for processes like mutual shading, chlorosis, senescence, viral infections, phenology, species biodiversity and hydrological status (Lillesaeter, 1982). A fast non-destructive imaging method to determine leaf chlorophyll content is therefore interesting for applications related to before mentioned processes.

The use of the leaf colour indicates that the estimation method is based on the visible part of the electromagnetic spectrum (± 400-700 nm). Different research projects have been performed to estimate chlorophyll content of leaves with optical non-destructive methods (Benedict & Swidler, 1961; Inada, 1964; Takano & Tsumoda, 1970; Wallihan, 1973; Hardwick & Baker, 1973; Macnicol *et al*., 1976, Thomas & Gaussman, 1977)mostly based on Red or NIR reflectance or absorbance. A well accepted method is based on the position of the red edge (λ_{pg}). This is the inflection point of a leaf reflectance spectral signature, typically between 680 and 740 nm (Barber & Horler, 1981; Ferns *et al*., 1984; Salisbury *et al*., 1987; Curran *et al*., 1991; Miller *et al*., 1991). Only a small subset of investigators managed to develop a chlorophyll method based on the visible part of the EM spectrum thus enabling the use of commercially available digital RGB camera's as well as building the capacity for chlorophyll imaging. Kawashima & Nakatani (1998) developed a field method for the estimation of leaf chlorophyll content using a video camera and image processing software. Unfortunately, these authors did not perform calibration, nor did they specify the spectral response functions of the video camera used. They neither predicted the transfer function to estimate leaf chlorophyll content applying leaf radiative transfer (RTF) modelling. Hence the repeatability of their method remains questionable.

In the work presented, the PROSPECT-DISORD-RAHMAN-6S (PDRS) RTF modelling environment is used to establish the transfer function for the estimation of chlorophyll content of Tilia sp., Zea mais L. and Cornus sp. using a commercially available RGB camera (Nikon Coolpix). The transfer function is validated with the destructive sampling of leaf chlorophyll content of the leaves of the plant species cited here above. The results of the methodological development will be presented and discussed.

Keywords: Leaf optics, non-destructive, chlorophyll content, RGB camera, physical modelling with PDRS.

Conference Theme: Physical modelling in the remote sensing of leaf chlorophyll content.

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