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Hyperspectral remote sensing of crop leaf chlorophyll content using reflectance simulation model and field data in open canopies

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Leaf chlorophyll content -a and -b content (Cab) is an indicator for crop nutrition status and photosynthetic capacity. Remote sensing of Cab plays an important role in crop growth monitoring, pest and disease diagnosis, and crop yield assessment, yet the feasibility and stability of such estimation has not been assessed thoroughly for mixed pixels when crop canopies are not closed.
This study analyzes the influence of spectral mixing on leaf chlorophyll content estimation using canopy spectra simulated by the PROSAIL reflectance model and the spectral linear mixture concept. It is observed that the accuracy of leaf chlorophyll content estimation would be degraded for mixed pixels using the well accepted approach of the combination of TCARI and OSAVI.
A two-step method was thus developed for winter wheat chlorophyll content estimation by taking into consideration the fractional vegetation cover using a look-up table approach. The two methods were validated using ground spectra, airborne hyperspectral data and leaf chlorophyll content measured the same time over experimental winter wheat fields. Using the two-step method, the leaf chlorophyll content of the open canopy was estimated from the airborne hyperspectral imagery with a root mean square error of 5.18 μg cm-2, which is an improvement of about 8.9% relative to the accuracy obtained using the TCARI/OSAVI ratio directly. This implies that the method proposed in this study has great potential for hyperspectral applications in agricultural management, particularly for applications before crop canopy closure. This study, therefore, offers a feasible technique that might be applied to crop chlorophyll content estimation using large-scale remote sensing data.