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Article

Combining Hyperspectral Reflectance Indices and Multivariate Analysis to Estimate Different Units of Chlorophyll Content of Spring Wheat under Salinity Conditions

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Abstract: Although plant chlorophyll (Chl) is one of the important elements in monitoring plant stress and reflects the photosynthetic capacity of plants, their measurement in the lab is generally time- and cost-inefficient and based on a small part of the leaf. This study examines the ability of canopy spectral reflectance data for the accurate estimation of the Chl content of two wheat genotypes grown under three salinity levels. The Chl content was quantified as content per area (Chl_{area}, μg cm^{-2}), concentration per plant (Chl_{plant}, mg plant^{-1}), and SPAD value (Chl_{SPAD}). The performance of spectral reflectance indices (SRIs) with different algorithm forms, partial least square regression (PLSR), and stepwise multiple linear regression (SMLR) in estimating the three units of Chl content was compared. Results show that most indices within each SRI form performed better with Chl_{area} and Chl_{plant} and performed poorly with Chl_{SPAD}. The PLSR models, based on the four forms of SRIs individually or combined, still performed poorly in estimating Chl_{SPAD}, while they exhibited a strong relationship with Chl_{plant} followed by Chl_{area} in both the calibration (Cal.) and validation (Val.) datasets. The SMLR models extracted three to four indices from each SRI form as the most effective indices and explained 73–79%, 80–84%, and 39–43% of the total variability in Chl_{area}, Chl_{plant}, and Chl_{SPAD}, respectively. The performance of the various predictive models of SMLR for predicting Chl content depended on salinity level, genotype, season, and the units of Chl content. In summary, this study indicates that the Chl content measured in the lab and expressed on content (μg cm^{-2}) or concentration (mg plant^{-1}) can be accurately estimated at canopy level using spectral reflectance data.

Keywords: content; concentration; different algorithm forms; non-destructive assessment; PLSR; phenotyping; remote sensing; SMLR