Green Leaf Area Index Estimation in Maize and Soybean: Combining Vegetation Indices to Achieve Maximal Sensitivity

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ABSTRACT

Vegetation indices (VIs), traditionally used for estimation of green leaf area index (gLAI), have different sensitivities along the range of gLAI variability. The goals of this study were to: (i) test 12 VIs for estimating gLAI in maize (*Zea mays* L.) and soybean [*Glycine max* (L.) Merr.]; (ii) estimate gLAI in both crops without the need to reparameterize the algorithms for different crops; and (iii) devise a combined VI that is maximally sensitive to gLAI along its entire range of variability. The study was performed for eight growing seasons (2001–2008) in one irrigated and one rainfed field under a maize–soybean rotation and one irrigated field under continuous maize in eastern Nebraska for a total of 24 field-years. The gLAI ranged from 0 to 6.5 m^2/m^2 in maize and 0 to 5.5 m^2/m^2 in soybean. Normalized difference indices, e.g., the normalized difference vegetation index (NDVI) were most sensitive to gLAI below 2 m^2/m^2, while ratio indices, e.g., simple ratio (SR) and chlorophyll indices (CIs), were most sensitive to gLAI above 2 m^2/m^2. For the crops evaluated, relationships between gLAI and the VIs were species specific with the exception of the red-edge NDVI and the $CI_{red\text{-}edge}$. To benefit from the different sensitivities of VIs along the entire gLAI range, we suggest combining VIs. For sensors with spectral bands in the red and near-infrared regions, the best combination was NDVI and SR (maize: coefficient of variation [CV] = 20%; soybean: CV = 23%); however, this combined index is species specific. For sensors with bands in the red-edge and near-infrared regions, the best combination was red-edge NDVI and $CI_{red\text{-}edge}$, which was capable of accurately estimating gLAI in both crops with a CV < 20% and with no reparameterization.