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Spectral variations of canopy reflectance in support of precision agriculture

Rumiana Kancheva, Georgi Georgiev, Denitsa Borisova, and Hristo Nikolov
SRTI-BAS, Remote Sensing Systems, Sofia, Bulgaria (hriston@bitex.com)

Agricultural monitoring is an important and continuously spreading activity in remote sensing and applied Earth observations. It supplies precise, reliable and valuable information on current crop condition and growth processes. In agriculture, the timing of seasonal cycles of crop activity is important for species classification and evaluation of crop development, growing conditions and potential yield. The correct interpretation of remotely sensed data, however, and the increasing demand for data reliability require ground-truth knowledge of the seasonal spectral behavior of different species and their relation to crop vigor. For this reason, we performed ground-based study of the seasonal response of winter wheat reflectance patterns to crop growth patterns. The goal was to quantify crop seasonality by establishing empirical relationships between plant biophysical and spectral properties in main ontogenetic periods. Phenology and agro-specific relationships allow assessing crop condition during different portions of the growth cycle and thus effectively tracking plant development, and finally make yield predictions. The applicability of a number of vegetation indices (VIs) for monitoring crop seasonal dynamics, its health condition, and yield potential was examined. Special emphasis we put on narrow-band indices as the availability of data from hyperspectral imagers is unavoidable future. The temporal behavior of vegetation indices revealed increased sensitivity to crop growth. The derived spectral-biophysical relationships allowed extraction of quantitative information about crop variables and yield at different stages of the phenological development. Relating plant spectral and biophysical variables in a phenology-based manner allows crop monitoring, that is crop diagnosis and predictions to be performed multiple times during plant ontogenesis. During active vegetative periods spectral data was highly indicative of plant growth trends and yield potential. The VIs values contributed to reliable yield prediction and showed very good correspondence with the estimates from biophysical models. For dates before full maturity most of the examined VIs proved to be meaningful statistical predictors of crop state-indicative biophysical variables. High correlations were obtained for canopy cover fraction, LAI, and biomass. Sensitivity to red, near-infrared and green reflectance showed both vigorous and stressed plants. As crops attained advanced growth stages, decreased sensitivity of VIs and weaker correlations with bioparameters were observed, yet still significant in a statistical sense. The results highlight the capability of the presented approach to track the dynamics of crop growth from multitemporal spectral data, and illustrate the prediction accuracy of the spectral models. The results are useful in assessing the efficiency of various spectral band ratios and other vegetation indices often used in remote sensing studies of natural and agricultural vegetation. They suggest that the used algorithm for data processing is particularly suitable for airborne cropland monitoring and could be expanded to sites at farm or municipality scale. The results reported are from pilot study carried out on a plot located in one of the established polygons for experimental crop monitoring. In the mentioned research GIS database is established for supporting the experiments and modelling process. Recommendations on good farming practices for medium sized farms for monitoring stress conditions such as drought and overfertilizing are developed.