REGIONAL ESTIMATION OF LEAF CHLOROPHYLL IN COTTON IN UZBEKISTAN BY UPSCALING A VEGETATION INDEX FROM PLANT SCALE TO PROBA-1/CHRIS HYPERSPECTRAL SATELLITE DATA

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ABSTRACT

Recommended nitrogen (N) application rates and timing for cotton production are not updated for the latest varieties in the Khorezm region, Uzbekistan. This may lead to over- or under fertilization and hence to environmental problems and income losses. To help adjusting N-fertilization we investigated tools for the estimation of leaf chlorophyll (Chl) *a+b* (that is closely related to leaf N status) in cotton at a leaf and plant scale in an upscaling strategy to finally provide a regional estimation of leaf Chl *a+b*. At a leaf scale, a Minolta SPAD-502 (SPAD) chlorophyll meter is calibrated to measure the absolute leaf Chl *a+b* and N status of representative leaves of cotton plants in a non-destructive manner. The prediction of SPAD-measured leaf Chl *a+b* status at a plant scale is performed by 16 spectral vegetation indices (VIs) based on sensing plant reflectance with an ASD-field spectrometer. The best performing VI at a plant scale is used to estimate Chl *a+b* for a study region at a regional scale by applying it to a Proba-1/CHRIS hyperspectral satellite image acquired on August 24th 2005. The correlation between SPAD values with leaf Chl *a+b* and N status analyzed in the laboratory showed an R^2=0.82 and R^2=0.71, respectively. These high correlations indicate a successful SPAD calibration and that leaf Chl *a+b* can be used as a proxy for leaf N. The best performing VI for the prediction of leaf Chl *a+b* in cotton plants was the "Transformed Chlorophyll Absorption in Reflectance Index (TCARI) (R^2 ca. 0.5). The best performance was achieved using both the upper leaves and leaves from the vertical plant profile in the regression with the spectral VI. The upscaling of TCARI to regional scale based on the Proba-1/CHRIS imagery provided the leaf Chl *a+b* distribution patterns that were spatially consistent with land cover units in the study site as well with measured leaf Chl *a+b* status of cotton within a validation field. However, the Proba-1/CHRIS-TCARI underestimated the measured leaf Chl *a+b* in the validation field by ca. factor 2. This may be due to scaling issues, since the satellite pixel resolution of 34 m contains the mixed reflectance of plants, bare soil in irrigation furrows and bare soil in larger spots that occur at several locations in the field due to salinity or other effects. Furthermore, the influence of soil background, plant and row structure on reflectance was not considered in the VI. Further research will address the leaf Chl *a+b* status of cotton during the prime growth stages with coordinated Proba-1/CHRIS image acquisitions of higher spatial resolution (17 m) and field measurements. For these periods VIs and radiative transfer model inversion approaches will be compared concerning their performance to estimate leaf Chl *a+b* status.