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# Assessment of plant nitrogen stress in wheat (*Triticum aestivum* L.) through hyperspectral indices

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A field experiment with wheat was conducted with four different nitrogen and four different water stress levels, and hyperspectral reflectances in the 350–2500 nm range were recorded at six crop phenostages for two years (2009–2010 and 2010–2011). Thirty-two hyperspectral indices were determined using the first-year reflectance data. Plant nitrogen (N) status, characterized by leaf nitrogen content (LNC) and plant nitrogen accumulation (PNA), showed the highest $R^2$ with the spectral indices at the booting stage. The best five predictive equations for LNC were based on the green normalized difference vegetation index (GNDVI), normalized difference chlorophyll index (NDCI), normalized difference$_{705}$ ($ND_{705}$) index, ratio index-1dB (RI-1dB) and Vogelman index a (VOGa). Their validation using the second-year data showed high $R^2$ (>0.80) and ratio of performance to deviation (RPD; >2.25) and low root mean square error (RMSE; <0.24) and relative error (<10%). For PNA, five predictive equations with simple ratio pigment index (SRPI), photochemical reflectance index (PRI), modified simple ratio$_{705}$ ($mSR_{705}$), modified normalized difference$_{705}$ ($mND_{705}$) and normalized pigment chlorophyll index (NPCI) as predicting indices yielded the best relations with high $R^2 > 0.80$. The corresponding RMSE and RE of these ranged from 1.39 to 1.13 and from 24.5% to 33.3%, respectively. Although the predicted values show good agreement with the observed values, the prediction of LNC is more accurate than PNA, as indicated by higher RMSE and very high RE for the latter. Hence, the plant nitrogen stress of wheat can be accurately assessed through the prediction of LNC based on the five identified reflectance indices at the booting stage.