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Artificial Neural Network and Satellite Derived Chlorophyll Indices for Estimation of Wheat Chlorophyll Content under Rainfed Condition

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Abstract : Numerous models used in prediction and decision-making process but most of them are linear in natural environment, and linear models reach their limitations with non-linearity in data. Therefore accurate estimation is difficult. Artificial Neural Networks (ANN) found extensive acceptance to address the modeling of the complex real world for the non-linear environment. ANN's have more general and flexible functional forms than traditional statistical methods can effectively deal with. The link between information technology and agriculture will become more firm in the near future. Monitoring crop biophysical properties non-destructively can provide a rapid and accurate understanding of its response to various environmental influences. Crop chlorophyll content is an important indicator of crop health and therefore the estimation of crop yield. In recent years, remote sensing has been accepted as a robust tool for site-specific management by detecting crop parameters at both local and large scales. The present research combined the ANN model with satellite-derived chlorophyll indices from LANDSAT 8 imagery for predicting real-time wheat chlorophyll estimation. The cloud-free scenes of LANDSAT 8 were acquired (Feb-March 2016-17) at the same time when ground-truthing campaign was performed for chlorophyll estimation by using SPAD-502. Different vegetation indices were derived from LANDSAT 8 imagery using ERADAS Imagine (v.2014) software for chlorophyll determination. The vegetation indices were including Normalized Difference Vegetation Index (NDVI), Green Normalized Difference Vegetation Index (GNDVI), Chlorophyll Absorbed Ratio Index (CARI), Modified Chlorophyll Absorbed Ratio Index (MCARI) and Transformed Chlorophyll Absorbed Ratio index (TCARI). For ANN modeling, MATLAB and SPSS (ANN) tools were used. Multilayer Perceptron (MLP) in MATLAB provided very satisfactory results. For training purpose of MLP 61.7% of the data, for validation purpose 28.3% of data and rest 10% of data were used to evaluate and validate the ANN model results. For error evaluation, sum of squares error and relative error were used. ANN model summery showed that sum of squares error of 10.786, the average overall relative error was .099. The MCARI and NDVI were revealed to be more sensitive indices for assessing wheat chlorophyll content with the highest coefficient of determination R^2=0.93 and 0.90 respectively. The results suggested that use of high spatial resolution satellite imagery for the retrieval of crop chlorophyll content by using ANN model provides accurate, reliable assessment of crop health status at a larger scale which can help in managing crop nutrition requirement in real time.

Keywords : ANN, chlorophyll content, chlorophyll indices, satellite images, wheat
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