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Assessing the within field spatial variability of crop growth status by remote sensing for site specific N fertilization management.

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In the frame of an experiment devoted to precision farming and more specifically to the definition of a site specific N application strategy (see Guérif et al., same issue), a methodology to estimate pertinent crop biophysical variables from remote sensing information is proposed. The originality of the approach consists in estimating the biophysical variables by taking into account their spatial variability into a field. We are especially interested in estimating the green leaf area index (gLAI), which characterizes the crop growth, and the chlorophyll content of the green foliage (CHL), which characterizes the crop nitrogen (N) nutrition status.

The proposed method consists in using models simulating the radiative transfer within the leaf and within the canopy to estimate gLAI and CHL from hyper-spectral reflectance measurements in the short-wave part of the spectrum (420 to 960 nm). The models are calibrated at local scale using ground reflectance measurements, and the method is extrapolated at the field scale using airborne reflectance measurements.

The study was conducted on a winter wheat field. Six test-sites (20 m x 10 m) were supplied with different fertilizer N rates : 0, 60, 120, 180, 240 and 300 kg/ha. The rest of the field (10 ha) received 240 kg N/ha in 4 applications. On the test-sites, LAI, CHL and N status were estimated using both destructive and non-destructive methods, allowing the calibration of nondestructive methods. A hand-held spectro-radiometer was used to characterize the radiometric response of leaves, soil and crop cover. Those measurements allowed a crop-specific calibration of both the leaf and canopy radiative transfer models. Thanks to the airborne radiometer, the spectral response of the whole field was available, with a 2m spatial resolution. Those data were used to upscale the inversion method at the field level taking into account the within field spatial variability. The output consists in a mapping of gLAI and CHL. The gLAI and CHL estimations were therefore compared to the non-destructive measurements of CHL and LAI performed on 22 points spatially distributed on a grid covering the whole field.

Remote sensing appears as an interesting tool for estimating the field heterogeneity of crop growth status and therefore making diagnosis (see Houlès et al in the same issue) and decision for variable rate N application.