Narrow-Band Vegetation Index Spectral Reflectance Sensors

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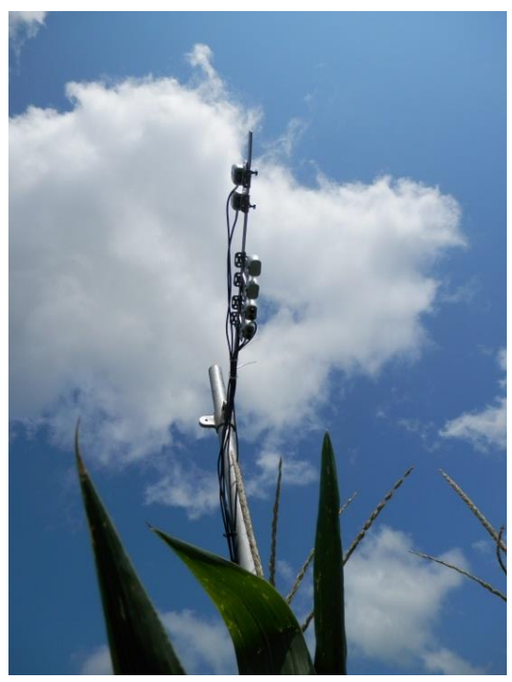
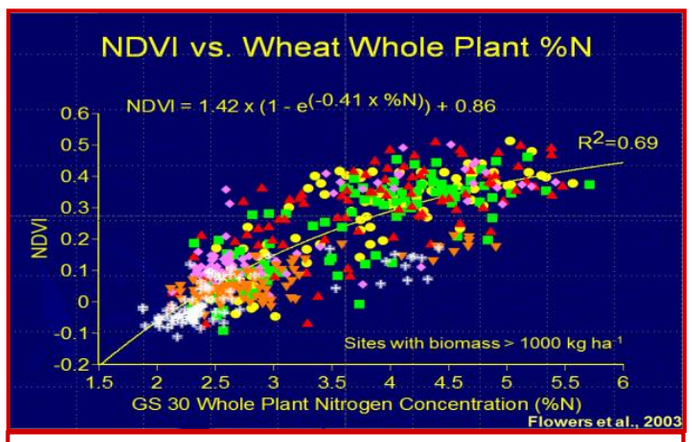


Here we demonstrate Decagon Devices* Spectral Reflectance Sensors used by AMPLIFY to monitor crop status in the field and to validate the hyperspectral imaging at four wavelengths. Each sensor measures crop canopy reflectance in two narrow spectral bands needed to generate a specific vegetation index. These are the Normalized Difference Vegetation Index, NDVI, and the Photochemical Reflectance Index, PRI.

NDVI is based on red and near-infrared canopy reflectance:

$$NDVI = \frac{NIR_{850\,nm} - Red_{650\,nm}}{NIR_{850\,nm} + Red_{650\,nm}}$$

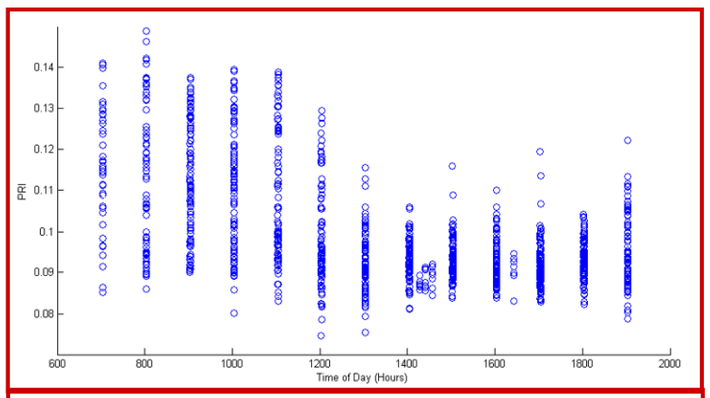


NDVI vs. early spring wheat tissue N concentration over multiple sites, years, and cultivars.

It exploits the fact that healthy plants absorb red light at 650 nm for photosynthesis and are highly reflective in the near-infrared at 850 nm. Values of both indices can range from -1 to 1. High NDVI values result when red reflectance is low due to absorption by chlorophyll, and NIR reflectance is high, which indicates healthy, un-stressed vegetation. NDVI can be used to estimate crop canopy cover (leaf area index), crop biomass, tissue N status, and crop stress. NVDI may be centered on other red/NIR wavebands such as 670 nm and 800 nm. The different spectral wavebands should produce slightly different (but correlated) NDVI.

PRI was designed to estimate photosynthetic light use efficiency based on reflectance of green light at 531 nm, which is a signature absorption wavelength of xanthophyll pigments. PRI uses yellow (571 nm) reflectance as a reference:

$$PRI = \frac{Green_{531\,nm} - Yellow_{571\,nm}}{Green_{531\,nm} + Yellow_{571\,nm}}$$



Diurnal PRI pooled over four corn genotypes and four population densities, Summer 2014.

Xanthophylls are non-photosynthetic pigments that protect the photosynthetic apparatus from excess light. PRI is correlated with photosynthetic light use efficiency and photosynthesis.

The down-looking sensors are “field-stopped” to create a 36° angular field of view. In the field, they are mounted above the canopy and measure light reflected from it as well as from any visible soil below. The up-looking sensors have a hemispheric field of view to measure incident radiation. Measuring both incident and reflected radiation allows true reflectance, $Reflectance = \frac{Reflected\ Light}{Incident\ Light}$, to be calculated and used in the NDVI and PRI equations. The sensors are connected to data loggers programmed to take measurements at frequent intervals.

*Brand names do no imply endorsement by NCSU nor our collaborators.