Seasonal Changes of Spectral Characteristics of Winter Wheat Based on Hyper-Spectral Radiometer

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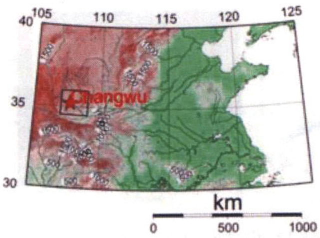
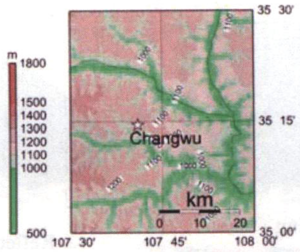
The spectral reflectivity of winter wheat by Hyper-spectral radiometer, the physiological indexes of the wheat, the meteorological variables, as well as the soil water contents were measured in the gully region of the Loess Plateau in China. The daily and seasonal change of spectral reflectivity and red edge position of winter wheat are studied from the observational data.

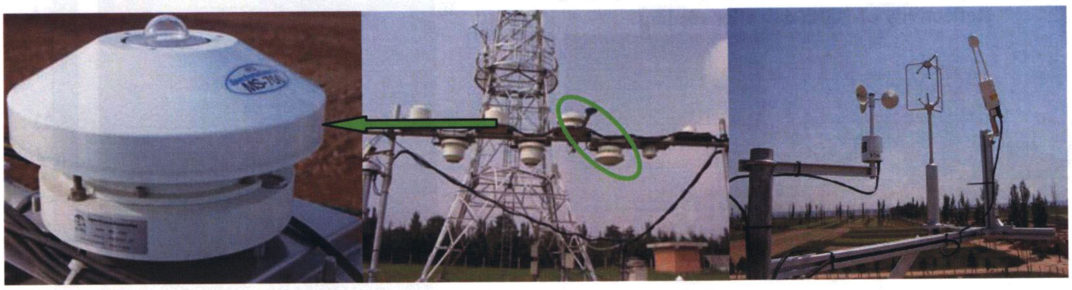
Site description:





Latitude:35° 14.5'N, Longitude:107° 41.1'E ;Altitude:1220 m; Annual mean temperature:9.1° C; Annual mean precipitation: 584 mm; Soil type: medium loam;Dominant vegetation: wheat, apple.

Apparatus:



Hyper-spectral radiometer (350nm-1050nm, 10nm res. [max]);
Ultrasonic anemometer thermometer; Open path CO2/H2O gas analyzer;

Calculation Methods:

Eddy covariance：(CO2 flux)

$$F_c = \overline{w}\,\overline{\rho_c} + \overline{w'\rho'_c}$$

$$= \mu \frac{\overline{\rho_c}}{\overline{\rho}} \overline{w'\rho'_w} + \left(1+\mu \frac{\overline{\rho_w}}{\overline{\rho}}\right) \frac{\overline{\rho_c}}{T} \overline{w'T'} + \overline{w'\rho'_c}$$ (Webb et al., 1980)

Filling data gaps:

nighttime: $F = b_0 \exp(b_1 T_{soil})$ daytime: $F = a_1 \cdot PAR/(a_2 + PAR) + a_0$

Normalized difference vegetation index :

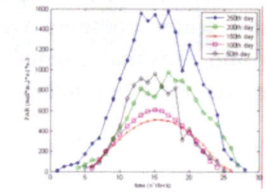
$$NDVI = \frac{\rho_{NIR} - \rho_{\mathrm{Red}}}{\rho_{NIR} + \rho_{\mathrm{Red}}}$$

Red edge position:

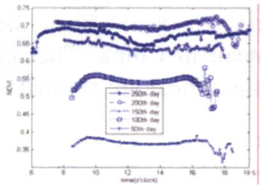
$$R'(\lambda_i) = \frac{R(\lambda_{i+1}) - R(\lambda_{i-1})}{\lambda_{i+1} - \lambda_{i-1}}$$

R-reflectivity; λ -wavelength; i- channel.

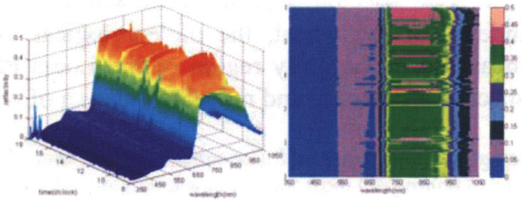
Results:



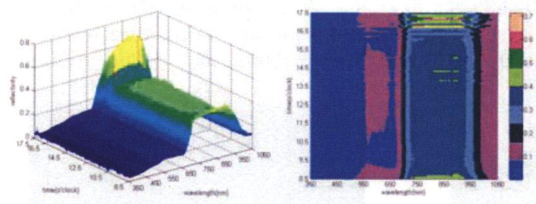
PAR of days after wheat seeding



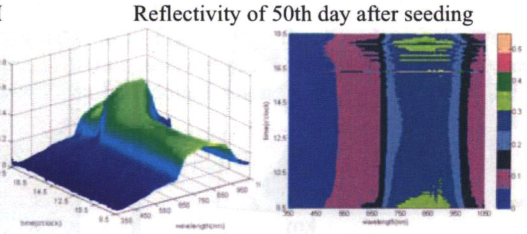
Changes of daily NDVI



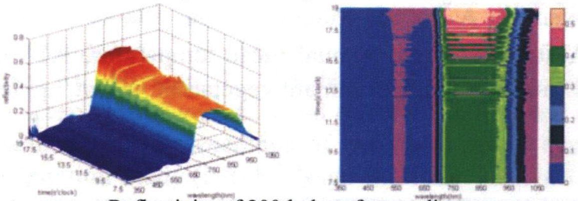
Reflectivity of 50th day after seeding



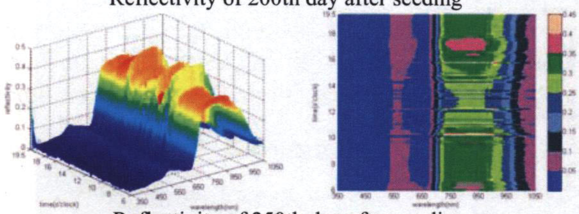
Reflectivity of 100th day after seeding



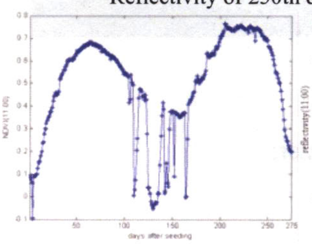
Reflectivity of 150th day after seeding

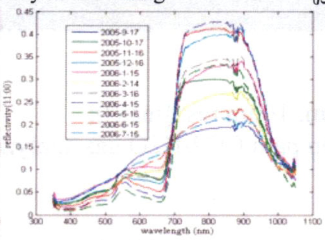


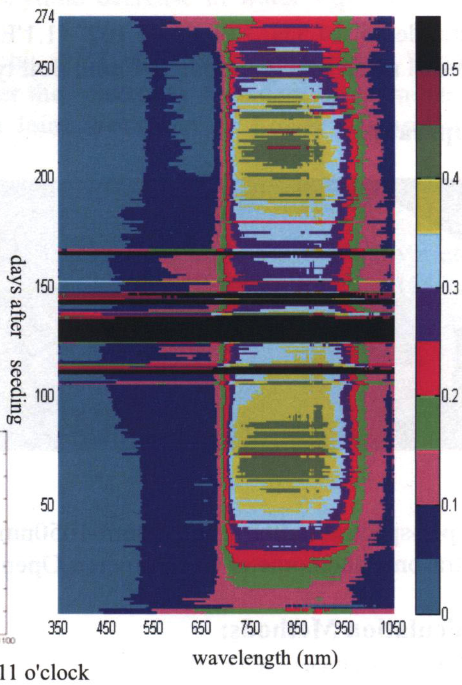
Reflectivity of 200th day after seeding



Reflectivity of 250th day after seeding







Reflectivity and NDVI at 11 o'clock

(1) The spectra reflectivity in different wavelength changed with the winter wheat growth duration. At the same time of different growth stages, the spectra reflectivity in visible light wavelength (350-670nm) changed little, while that of near-infrared bands (700-1050nm) varied greatly. The daily spectra reflectivity in the whole growth duration changed with solar altitude

angle, and the bands (around 550 nm, 700-1050 nm) in which the reflectivity changed most were the wave peak.

（2）The daily NDVI changed in U-shape, which were minimum at about 13:00, and fluctuated after 16:00. In the whole growth duration, the reflectivity and NDVI were symmetrical about the 140^{th} day after seeding when satellite passed the field. The NDVI changed in M-shape, which reached the two peak values, 0.684 and 0.755 respectively, in the 65^{th} day and 223th day after seeding. The NDVI reached the minimum value of 0.35 in the 158^{th} day after seeding.

（3）Red edge positions moved to longer wavelength during the period of emergence , tillering and the end of wintering, and moved to shorter wavelength during the beginning of wintering period. It was not obvious that red edge positions moved to shorter wavelength during mature stage.

(4)There was significantly negative correlationship between the NDVI and daily budget of CO2 during the whole growth duration of wheat ($r=-0.62$, $p<0.01$).