LIFE-CYCLE SPECTRAL VARIATION ANALYSIS OF CORN LEAVES USING HYPERTEMPORAL AND HYPERSPECTRAL IN SITU MEASUREMENT DATA

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1.INTRODUCTION

The temporal variation of spectrum of vegetation is considered as the most valuable signals to extract the information of the biophysical and biochemical parameters of vegetation, and at the same time, it also adding uncertain noises to other useful signals in the applications of crop monitoring using technology of remote sensing.

2.DATA

To determine the spectral variation patterns of the corn leaves, an entire life-cycle spectral data of live corn leaves was measured using an Integrating Sphere(Li-Cor1800, Lincoln, NE, USA) and a Spectroradiometer(ASD FieldSpec Pro FR^{TM}, Boulder, CO, USA). The measurement site is located at the corn sample of Beijing Normal University, Beijing, China. The field spectral data was collected every 4 days from June 16th to September 25th in the year of 2005. After preprocessing procedure and SNR(Signal to Noise Ratio)analysis, 400nm to 960nm is chosen as our discussion spectral reflectance range.

3.METHOD

3.1. Determination of characteristic wavelengths

Eight characteristic wavelengths are selected to investigate the spectral variation of corn leaves: blue-violet light absorbing peak(M:minimum value of the spectrum from 382nm to 500nm), blue edge(B:maximum value of the first-order derivative of the spectrum from 450nm to 550nm), green reflectance peak(G:maximum value of the spectrum from 500nm to 600nm), yellow edge(minimum value of the first-order derivative of the spectrum from 550nm to 650nm), red absorbing peak(R:minimum value of the spectrum from 600nm to 720nm), red edge(V:maximum value of the first-order derivative of the spectrum from 670nm to 780nm), first wavelength of infrared plateau(I1,first wavelength of infrared plateau from 670nm to 800nm after continuum removal), maximum of infrared plateau(I:maximum value of the spectrum from 780nm to 950nm).

3.2.Statistic of the characteristic wavelengths

Statistic of the characteristic wavelengths of live corn leaves is developed to determine whether they will change by stage of life cycle, position of foliage, or other potential factors without any environmental stress.

3.3.Temporal variation of reflectance of the stable characteristic wavelengths

Time series reflectance data is fitted using the least squares fitting method to explore whether the spectral variation of stable characteristic wavelengths can be depicted by explicit mathematical equations. The temporal variation curve of stable characteristic wavelengths shows that the wave hollow of reflectance of the red absorbing peak(R: 658nm) arrives earlier than wave hollows of reflectance of other characteristic wavelengths. As the reflectance is highly negative correlation with absorption of this wavelength, a qualitative hypothesis is given to explain this phenomenon.

3.4.Three dimensions model of reflectance of corn leaves

The reflectance of corn leaves during the entire life cycle can be described as a function of wavelength, time and reflectance. The spectral reflectance is divided into three parts: 400nm to 550nm, 550nm to 660nm and 660nm to 960nm.The temporal and spectral variation of reflectance is modeled using mathematical expressions.

4.CONCLUSION

The result of this research can be concluded as follow:
(1)seven characteristic wavelengths(M:382nm, B:523nm, G:552nm, Y:568nm, R:658nm, V:723nm, I1:767nm) are quite stable without any environmental stress, which are nearly immune to stage of life cycle, position of foliage or other potential factors;
(2) the maximum of infrared plateau is not a well defined and stable characteristic wavelength, there are at least two reflectance variation treads from 770nm to 950nm, which can be considered as one of the most important reason which result in uncertainties of vegetation indices;
(3)the reflectance-time curve of the five characteristic wavelengths(B:523nm, G:552nm, Y:568nm, R:658nm, V:723nm) can be well fitted by 5 quadratic polynomial equations with a $R^2>0.76$;
(4)The life-cycle reflectance can be modeled as a three dimensions surface(time, wavelength and reflectance). Therefore, we can use it to predict the reflectance of live corn leaves of any wavelength and any stage of life cycle.

5.REFERENCES

[1] Tan Qian, Zhao Yongchao, Tong Qingxi, et al, "Vegetation Spectral Feature Extraction Model", *Remote Sensing Information*, National Remote Sensing Center of China, Beijing, pp.14-18, 2001.