RESEARCH ON NUTRITION DETECTION TECHNOLOGY OF SOIL AND LEAF OF CITRUS BASED ON SPECTROSCOPIC TECHNIQUES

S.L. Yi , L. Deng, S.L. He, Y.Q. Zheng

Citrus Research Institute
Southwest University-Chinese Academy of Agricultural Sciences
Chongqing, China

ABSTRACT

The diagnosis technique of real-time lossless crop nutrition is the foundation and conditions for the precise and effective fertilization. Currently, the diagnosis of crop nutrition mainly relies on the routine chemical analysis of laboratory. Due to the complicated procedure, time-consuming, high cost and high professional technique requirement, it can hardly meet the need of precise variable fertilization technology. Spectrum technology is the technology of real-time and non-destructive testing, and its development has rapidly promoted in recent years. Therefore, it is widely adopted in many fields, such as Chinese medicine chemical analysis, on-line quality control, while less adopted in real-time diagnosis of field crop research and progressed slowly. In order to explore the diagnostic technology based on spectrum of soil and leaf nutrient in citrus orchard and provide evidence for the development of real-time, accurate, and non-destructive citrus nutrition, we have carried out real-time detection technology research in citrus orchard based on the visible-near infrared spectroscopy detection of the soil and leaf nutrient element contents.

Keywords: Three Gorges Reservoir Area; Citrus; Nutrient elements; Visible-near infrared spectroscopy; Partial least-squares method; Detection

METHODS AND CONCLUSIONS

(1)The relationship between the spectrum characteristics and nitrogen content of soils in citrus orchard of the Three Gorges Reservoir Area was studied by analyzing the visible near-infrared spectrum. The collected soil samples were made of 20 mesh and 60 mesh dry weight, leaves samples made of powder samples. The results showed that the soil reflectivity increased lineally as the wavelength increases across the visible spectrum and reached a stable plateau in the short wavelength near-infrared region (780-1750nm) without much fluctuation. In the long wavelength near-infrared region (1750-2400nm) the reflectivity of the soils was higher with higher fluctuation. There were three strong absorbance peaks around 1416 nm, 1913 nm and 2209 nm, respectively in the long wavelength infrared region. Soil available nitrogen content and total nitrogen content were positively correlated with soil light reflectivity but negatively correlated with catoptrics-spectrum values reciprocal logarithm. At 541 nm of visible light region, a high positive correlation was found between the available nitrogen content and the first derivative of the soil reflective spectrum with a correlation coefficient of +0.605 and the best fitting equation was $y = 2E+09x^2–3E+06x+890.49$, where $R^2 =0.5$, and x is the first derivative of the soil reflective spectrum. At 1909 nm of the near-infrared long wavelength region,

the correlation between the total nitrogen content and the reciprocal-log values of the reflective spectrum of the soils was the best with a correlation coefficient of -0.612, and the best fitting equation was $y=1.3721x^2–2.1075\ x+0.8592$, where $R^2=0.4$, and x is the reciprocal values of the log reflective spectrum of the soils (Fig. 1).

(2)Visible/near-infrared(VNIR) spectroscopy appears as a prominent technique for non-destructive evaluation. In this research, the potential of using the VNIRS was investigated for measuring the nitrogen content in Peng'an 100 Jincheng orange leaves, and the relationship was established between non-destructive VNIRS measurement and the nitrogen content in Peng'an 100 Jincheng orange leaves. Intact Peng'an 100 Jincheng orange leaves were measured by reflectance VNIR in 350–1000 nm range. The data set as the reflectance VNIR was analyzed in order to build the best prediction model for these characteristic, using several spectral pretreatments such as First Derivatives Spectrum (FDS), Second Derivatives Spectrum (SDS) and Reciprocal Logarithm Spectrum (Log (1/R)) with Standardization of Variables (SNV) techniques. The results showed the reflectance spectrums of leaves presented downward trend within 350-700 nm and upward trend within 750-1000 nm with the increasing of the nitrogen fertilizer in potted plant of Peng'an 100 Jincheng orange (Citrus sinensis L. Osbeck) on trifoliate (Poncirous trifoliata) rootstock. The model for the nitrogen content in Peng'an 100 Jincheng orange leaves prediction using FDS with SNV spectral pretreatments showed an excellent prediction performance. This non-destructive, fast and accuracy technology can be used in citrus industry that would be beneficial to predict the plant nutrition (Fig. 2).

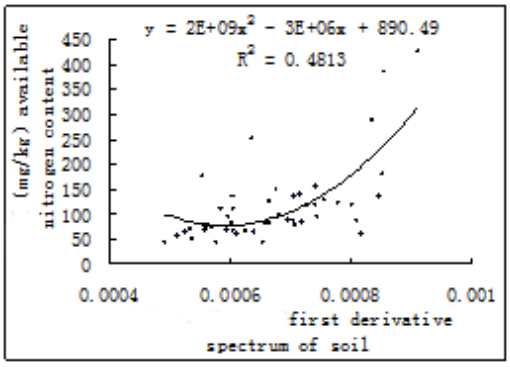

Fig.1 The fitting model of the available nitrogen and first derivative spectrum (541nm)

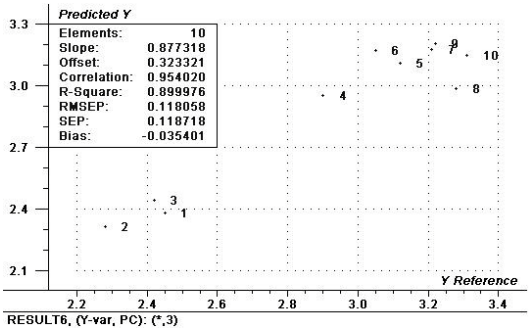

Fig.2 The relationship between predictive and true values in summer shoot leaves of Peng'an 100 Jincheng

ACKNOWLEDGEMENTS

This study was co-funded by Chongqing Major Tackling Program (CSTC, 2006), the Chinese Science and Technology Supporting Plan Program (2007BAD47B04) and was co-sponsored by Chongqing Cytology Key Laboratory and the Pomology Key Laborotary of Chongqing Educational Department. The author also wants to thanks for the contributions provided by Mr. Liang Wang, Xuyang Zhao and Miss. Tingxiang Niu.