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论文

基于高光谱的土壤全氮含量估测

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摘要:

基于高光谱(350~2 500 nm)数据,研究了我国中、东部地区5种主要类型土壤全氮含量与高光谱反射率之间的定量关系,构建了基于偏最小二乘法(PLS)、BP神经网络(BPNN)和特征光谱指数的土壤全氮含量估算模型。结果表明,以500~900 nm、1 350~1 490 nm区域波段反射率经Norris滤波平滑后的一阶导数光谱为基础,构建的基于PLS和BPNN的土壤全氮含量估算模型精度较高,建模决定系数分别为0.81和0.98;独立观测资料检验结果显示,模型预测决定系数分别为0.81和0.93,均方根误差*RMSE*为0.219 g•kg^{-1}和0.149 g•kg^{-1},相对分析误差*RPD*为2.28和3.36,说明PLS和BPNN模型对土壤全氮含量具有较高的预测精度。在光谱指数的分析中,基于近红外872 nm和1 482 nm 两个波段的差值光谱指数$DI(NDR_{872},NDR_{1482})$对土壤全氮含量最敏感,建模决定系数、预测决定系数、*RMSE*和*RPD*分别为0.66、0.53、0.31 g•kg^{-1}和1.60。比较而言,三种方法估算土壤氮含量的精度顺序为BPNN模型>PLS>$DI(NDR_{872},NDR_{1482})$,基于PLS和BPNN两种方法建立的土壤全氮含量高光谱估测模型具有较高的精度,可以用来精确估算土壤全氮含量;基于两波段构建的$DI(NDR_{872},NDR_{1482})$预测效果低于前两者,但也可以用来粗略估测土壤中的全氮含量。

关键词: 土壤 全氮 高光谱 偏最小二乘法 BP神经网络 光谱指数

Estimating Soil Total Nitrogen Content Based on Hyperspectral Analysis Technology

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Abstract:

Quantitative relationships between soil total nitrogen content (TN) and hyperspectra in visible and near-infrared region (VIS-NIR) (350-2500 nm) were studied for five soil types (paddy soil, fluvo-aquic soil, salinized fluvo-aquic soil, saline soil, dark soil with lime concretion) collected from central and East China. Based on three different methods of spectral index, partial least square (PLS) and back propagation neural network (BPNN), the models were developed for estimating TN content in soil. The results showed that the newly developed PLS and BPNN models for estimating TN content based on the corrected first derivative spectra of 500-900 nm and 1350-1490 nm regions with Norris smoothing filter performed well, with R^2 of calibration as 0.81 and 0.98, respectively. The R^2, *RMSE* and *RPD* of validation were 0.81, 0.219 g•kg^{-1} and 2.28 for the method of PLS, and were 0.93, 0.149 g•kg^{-1} and 3.36 for the method of BPNN, respectively. In addition, $DI\ (NDR_{872},\ NDR_{1482})$ composed of the corrected first derivative spectra of 872 nm and 1482 nm with Norris smoothing algorithm also had a good correlation with soil TN content. Testing of the estimating model based on $DI(NDR_{872},\ NDR_{1482})$ with independent datasets from different types of soil samples resulted in R^2, *RMSE* and *RPD* as 0.66, 0.53 g•kg^{-1} and 1.60, respectively. Comparison of the above three methods, the sequence of prediction accuracy was PLS-BPNN model>PLS>$DI(NDR_{872},\ NDR_{1482})$, which indicated that the newly developed BPNN and PLS models were reliable for estimating soil TN content with high prediction accuracy, and $DI(NDR_{872},\ NDR_{1482})$ maybe a good indicator of soil TN content.

Keywords: soil total nitrogen hyperspectra partial least square BP neural network spectral index

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