梅慧兰,邓小玲,洪添胜,罗霞,邓晓玲.柑橘黄龙病高光谱早期鉴别及病情分级[J].农业工程学报,2014,30(9):140-147

柑橘黄龙病高光谱早期鉴别及病情分级

Early detection and grading of citrus huanglongbing using hyperspectral imaging technique

投稿时间： 2014-02-14 最后修改时间： 2014-03-20

中文关键词：无损检测 分级 模型 高光谱成像 偏最小二乘判别 黄龙病 早期鉴别

英文关键词:nondestructive examination grading models hyperspectral imaging partial least squares discriminant analysis huanglongbing (HLB) early detection

基金项目:国家自然科学基金（青年基金）（31201129）；现代农业产业技术体系建设专项资金（CARS-27）；广东省教育厅高校优秀青年创新人才培养计划（2012LYM_0028）；教育部高等学校博士学科点专项科研基金（20124404120006）

作者	单位
梅慧兰	1. 华南农业大学工程学院，广州 5106422. 华南农业大学南方农业机械与装备关键技术教育部重点实验室，广州 5106423. 国家柑橘产业技术体系机械研究室，广州 510642
邓小玲	1. 华南农业大学工程学院，广州 5106422. 华南农业大学南方农业机械与装备关键技术教育部重点实验室，广州 5106423. 国家柑橘产业技术体系机械研究室，广州 510642
洪添胜	1. 华南农业大学工程学院，广州 5106422. 华南农业大学南方农业机械与装备关键技术教育部重点实验室，广州 5106423. 国家柑橘产业技术体系机械研究室，广州 510642
罗霞	1. 华南农业大学工程学院，广州 5106422. 华南农业大学南方农业机械与装备关键技术教育部重点实验室，广州 5106423. 国家柑橘产业技术体系机械研究室，广州 510642
邓晓玲	4. 华南农业大学资源环境学院柑橘黄龙病研究室，广州 510642

中文摘要：

为实现柑橘黄龙病的早期、快速确诊，有效阻止病害蔓延，达到早期防治、保障柑橘生产的目的，该文研究基于高光谱成像的柑橘黄龙病早期无损检测及病情分级，并对多种预处理方法的建模结果进行探讨。试验获取370～1 000 nm健康、不同染病程度及缺锌共5类柑橘叶片的高光谱图像，用遥感图像处理平台（environment for visualizing images，ENVI）得到各类样本感兴趣区域的光谱反射率平均值。运用一阶微分、移动窗口拟和多项式平滑（savitzky-golay，SG）进行数据处理，结合偏最小二乘判别分析（partial least squares-discriminate analysis，PLS-DA）构建黄龙病的早期鉴别及病情分级模型。结果表明：建立的3个判别模型，验证集相关系数均不低于0.9548。其中，经SG平滑及一阶微分预处理所建立的模型分类效果最佳，总体预测准确率达96.4%，预测均方根误差0.1344。该研究为柑橘病害早期诊断和预警提供了新方法，也为黄龙病病害程度遥感监测提供了基础。

英文摘要：

Abstract: Timely, accurate, rapid diagnosis and grading of citrus Huanglongbing (HLB), a devastating disease severely influencing the citrus industry in the world, plays a very important role in guaranteeing the yield, the quality of citrus fruits, and the benefits of citrus growers. Based on a hyperspectral imaging technique, this paper not only focused on the method of early nondestructive detection and grading of citrus HLB disease, but also tried to discuss the influence of different data preprocessing methods on the modeling results. What is more, the varying reflection spectral characteristics of citrus leaves in diverse disease degrees were analyzed in the paper based on measured hyperspectral data.Hyperspectral images of five kinds of citrus leaves, including the healthy, infected with different degrees with HLB, and those with zinc deficiency, were acquired through experiments by a hyperspectral imaging system with the wavelength range of 370-1 000 nm, and then the average spectral reflectance data of region of interests of different kinds of leaf samples were obtained by utilizing the environment for visualizing images(ENVI). By taking advantage of a partial least squares-discriminate analysis (PLS-DA) method, three models of the early diagnosis and grading of HLB disease, tested with a leave-one-out cross-validation strategy, were established with original spectral data and data preprocessed by different data pretreatment methods, such as first derivative and moving window polynomial fitting smoothing (Savitzky-Golay smoothing,SG). In the end, the predictive performances of all of the three models were compared and analyzed with the new validation data.As a result, the cross-validation correlation coefficients of three discriminate models were all greater than 0.9548, however, their prediction performances were not the same. The detection results of the first discriminate model, established with original data, was not satisfactory. The second discriminate model, set up with data pretreated by a first derivative method, could basically identify the three types of HLB correctly: the mottled, yellowing, and no obvious symptoms, but there were quite a few healthy samples and zinc deficiency samples misjudged as HLB disease. What was satisfying was that the third model established with spectral reflectance data preprocessed by the Savitzky-Golay smoothing and first derivative methods had the best discriminate effect, which achieved prediction accuracy of no less than 92% of five kinds of leaf samples, the overall classification accuracy rate was 96.4% (in a test set of 250 samples, 241 having been correctly indentified), as well as RMSEP of 0.1344. In addition to these, its prediction accuracy for the healthy, zinc deficiency samples were 92% and 96%, which meant that there were still a few samples having been mistaken for HLB disease. As for the unobvious symptom, the mottled, and the yellowing samples, although some wrong judgments still existed among them, at least all of the three types could be correctly identified as infected with HLB. No matter what, the above research results showed that this method for early, nondestructive diagnosis of citrus HLB was of great significance and feasibility. The research was able to provide a new method for early detection and pre-warning of citrus disease, and also lay a basis for remote sensing monitoring of HLB disease degrees.

查看全文 下载PDF阅读器

关闭

主办单位：中国农业工程学会 单位地址：北京朝阳区麦子店街41号

服务热线：010－65929451 传真：010－65929451 邮编：100125 Email：tcsae@tcsae.org