Chapter 8
Detection of Diseases and Volatile Discrimination of Plants: An Electronic Nose and Self-Organizing Maps Approach

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ABSTRACT

The diagnosis of plant diseases is an important part of commercial greenhouse crop production and can enable continued disease and pest control. A plant subject to infection typically releases exclusive volatile organic compounds (VOCs) which may be detected by appropriate sensors. In this work, an Electronic Nose (EN) is employed as an alternative to Gas Chromatography - Mass Spectrometry (GC-MS) to sample the VOCs emitted by control and artificially infected tomato plants. A case study in which powdery mildew and spider mites may be present on tomato plants is considered. The data from the EN was analyzed and visualized using Fuzzy

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C-Mean Clustering (FCM) and Self-Organizing Maps (SOM). The VOC samples from healthy plants were successfully distinguished from the infected ones using the clustering techniques. This study suggests that the proposed methodology is promising for enhancing the automated detection of crop pests and diseases and may be an attractive tool to be deployed in horticultural settings.

INTRODUCTION

The main objectives of a rapid plant disease detection system are first to determine if the plant is unhealthy or stressed and second to find the reasons a plant is unhealthy which will lead to a proper diagnosis and treatments. Reliable disease detection is vitally important to assist disease and pest control within both large and medium scale commercial greenhouses for economic, production, and horticultural benefits. The process of plant disease diagnosis is a complex and multifaceted one but in recent years there have been diverse modifications of existing procedures for detection of plant pathogens and rapid advancement in research for new technologies and enhanced instrumentations. Visual inspections by growers as well as laboratory based methods such as Light Microscopy, Polymerase Chain Reaction (PCR), Serology, Double-Stranded RNA Analysis and Nucleic Acid probes are within the most widely used procedures of plants pest and disease diagnosis (Putnam, 1995). In spite of availability of these methods, the laboratory based techniques are often time consuming, expensive, require destructive sampling and necessitate skilled experts. Therefore, there is a demand for a fast and sensitive method for the rapid detection of plant diseases. More recent methods such as spectroscopic and imaging techniques as well as the application of analyzing the VOCs emitted by plant as possible biomarkers for disease detection have been studied by researchers (Laothawornkitkul et. al, 2008). These methods could be deployed in an agricultural setting for a rapid, reliable and real-time plant disease monitoring and management. The early detection of crop diseases prior the onset of disease symptoms and visual signs, may be a very valuable source of information for executing appropriate pest management strategies and disease control measures by growers to prevent the spread of diseases within the commercial greenhouses (Sankaran et al., 2010).

In this chapter, we investigate plants behavior when infected by pest and disease and explore the possibility of employing gas sensor arrays coupled with suitable intelligent systems technique to categories the VOCs emitted by the plants. In next section we will debate the plant systematic approach in terms of emitting VOCs when under attacked by pest and diseases.