Sniffing out disease

Roel Jensen, *Wageningen University*

Dutch researchers are working on identifying disease from volatile substances before any plant symptoms occur.

Research from Holland on early identification of plant disease from odours, provides a potential disease management tool in glasshouses. Combined with precision technology could these techniques be of relevance to paddock production?

The smells in your garden are often rich and differ in intensities. Blossoms can smell sweet, spicy, woody or be strongly intoxicating. For decades, floral scent was difficult to measure or even to describe. Therefore, vague terms were often related to scents such as warm, fruity, fresh or even sensual. We now know that a plant's scent is a unique combination of volatile compounds, organic molecules that evaporate off the leaves, filling the air with perfume to attract pollinators. However, until recently, no one anticipated that volatile compounds emitted by plants provide important information relating to the plant's health status.

In 1984, Prof. Marcel Dicke at Wageningen University, The Netherlands, discovered that plants actively release volatile substances after insect damage. These volatile substances were found to attract predators of the herbivorous insects, so they functioned as bodyguards. This resulted in the concept 'the enemy of your enemy is your friend', which is still a hot topic in plant sciences.

Several years later, it became clearer that volatile compounds released by plants are able to transfer information between plants and insects. Therefore, they were termed 'infochemicals'. These infochemicals play an active role as bodyguards and in inter-plant and plant to plant communication. Furthermore, these volatile chemicals serve as a disinfectant for bacterial and fungal infections and probably play a role in plant protection against harmful gases, such as high ozone concentrations.

So, plants release volatiles when they are stressed by pathogen infection, bacterial infection or herbivore attack. Technologically, it is likely that commercially available sensors would be able to detect these compounds. Applying such sensors in a greenhouse could lead to an early-warning monitoring system, in which greenhouse managers would be warned of plant stress before visual symptoms occurred.

Plants release volatile substances when they are stressed by insect and disease attack

To test this hypothesis we selected the tomato as a model. The tomato was selected because it is a commercially important crop throughout the world —both for the fresh fruit market and the processed food industries. In the Netherlands it covers about 1400 hectares or one-third of the Dutch greenhouse vegetable area. The plant pathogen Botrytis was selected as stressor because this fungal pathogen is among the most important and devastating disease problems for tomato growers worldwide. This disease affects fruits and stems, as well as leaves.

The research started in 2005, when detached tomato leaves were inoculated with Botrytis and placed in a Petri dish. Identification of the air surrounding the leaf confirmed the emission altered and a clear difference was observed between inoculated and control leaves.

In 2006, the process was scaled-up enabling the analysis of the emission from four intact tomato plants in a closed glass chamber. This enclosure was required to prevent contamination of the air surrounding the plants. In addition, this set-up enabled the identification of disease discriminatory compounds at an early stage, before visible symptoms appeared on the leaf surface.

During 2007, further experiments will be conducted to validate our theories in a semi-closed greenhouse of 45 square meters. This last step is the most exciting, as it approaches practical conditions similar to those found in Dutch greenhouses. Initial results indicate that it is easy to detect artificial damage due to touching of the plants.

My challenge is to develop a monitoring system for greenhouse crops based on volatile sensing. To do this I need to combine knowledge of chemistry, biology and engineering. It is important to know how cultivation is arranged inside a greenhouse. Plant-pathogen interaction and the role of light, humidity and temperature on this interaction need to be fully understood. Finally, knowledge of maths and sensor technology is required as most sensors deliver enormous amounts of data that need to be automatically processed and interpreted. I hope that you can share this challenge with me or think about it while you eat your tomato.

For more information
Roel Jansen
Wageningen University
The Netherlands
Roel.Jansen@wur.nl