Early detection of apple scab in apple leaves; development of a Crop Health Sensor (CHS)

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Introduction

In the EU-FP6 ISAFRUIT project a Crop Adapted Spray Application system for precision crop protection (Doruchowski *et al*., 2009) was developed. The system ensures efficient and safe spray application in orchards according to actual needs and with respect to the environment. The system consists of three components: Crop Identification System – CIS (Balsari *et al*., 2009), Environmentally Dependent Application System – EDAS (Doruchowski *et al*., 2009), and a Crop Health Sensor – CHS. To develop the CHS, spectral analysis has been used, based on the developments in crop sensing techniques for grassland and arable crop production (Schut, 2003). Crop health status, with as an example the infection of apple scab (*Venturia inequalis*) on apple leaves, has been evaluated. This paper describes the first results of the spectral measurements done to distinguish typical reflection wavelength from healthy apple leaves and apple scab infected leaves in time after infection.

Methodology

A measuring tool developed for characterizing grass-swards has been adapted to measure picked single apple leaves placed on the floor underneath in the laboratory. The device measures with two cameras the reflection in the band-widths 400-900nm and 900-1650nm. With this device spectral analysis measurements were performed on individual apple leaves of different apple varieties (Elstar, Jonagold, Rubens, Wellant, Autento). Both young shoots and old leaves were measured on the top and underside. For the varieties Elstar and Jonagold scab and mildew infected leaves were also measured. In a second series of experiments spectral reflection of individual leaves of two cultivars (Gala, M9 rootstock), were taken to observe the change in spectrum in time. A difference was made between healthy and disease infected leaves (conidia of apple scab) evaluated on 2 hours, 4 hours, 8 hours, 24 hours, 2 days, 14 days and 28 days after infection.

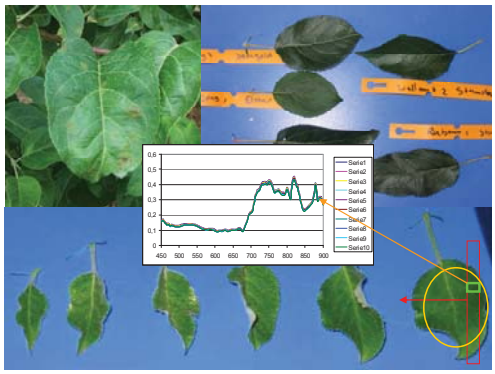

Figure 1. *Apple leaves were scanned in lines (1mm x 120mm) for spectral reflection with two cameras (400-900 nm and 900-1650nm wavelength) per mm*^{2} *to determine areas of difference in reflection between cultivar, healthy leaf and apple scab infected leaf.*

Results

Assessment of leaves of the apple cultivars Elstar, Jonagold, Autento, Wellant and Rubens on the spectral reflectance showed that the apple varieties could be discriminated from each other based on spectral reflectance. Healthy parts of the leaves can be distinguished from diseased parts of the leaves on the mm^2 level. Assessment of the time after infection of leaves with apple scab (apple varieties Gala and M9) showed

that early detection as 2 days after infection was possible based on spectral reflectance, whereas visual detection is only possible after 10-12 days when first symptoms become visible.
The early detection of apple scab using spectral reflectance on the leaf opens new ways to develop a Crop Health Sensor (CHS) to be used for apple scab detection in the orchard and adapt the crop protection strategy as well. To translate the mm^2 information to an evaluation directly in the orchard at the leaf and tree level is still a big step to be made.

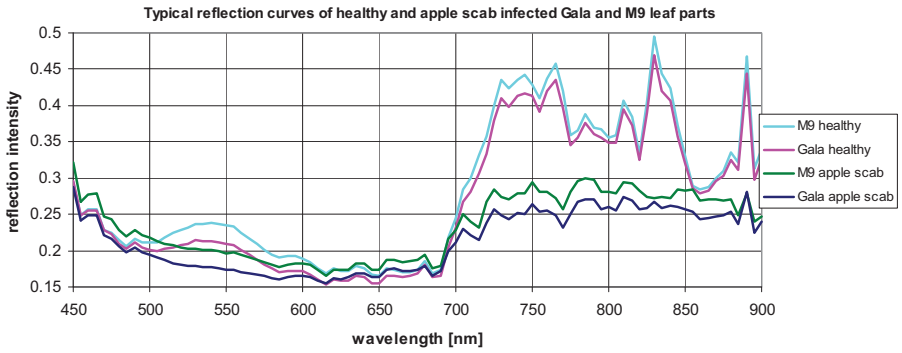

Figure 2. *Spectral reflectance curves of healthy and apple scab infected Gala and M9 apple leaves*

References

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