Hyperspectral imaging - an innovative tool to detect plant diseases for IPM

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Abstract

Hyperspectral imaging is one of the promising methods for a precise, reproducible and objective estimate of plant diseases for integrated pest management, precision crop protection or in plant breeding for the selection of disease resistant genotypes. This technique can further support the decision making process for integrated pest management practices in the field or in the greenhouse. Here the timing of pesticide application has to be precise with an appropriate active ingredient. For this purpose a detection and identification of plant diseases in an early stage is requisite. Since the response of visual disease rating by the human eye is not reproducible and depends on several factors, optical hyperspectral sensors are promising tools for detection and monitoring of plant diseases. One advantage of these measuring methods is the non-invasive and non-destructive nature. Innovative sensor systems can provide detailed and highly resolved information on crop systems and single plants. Plant diseases impact the optical properties of host plants depending on the host pathogen interaction in different ways. These modifications in plant biochemistry or physiology or pathogen specific structures can be assessed by hyperspectral imaging. The disease specific spectral pattern in time and space can be used for a monitoring of plant diseases.

Within the CropSense.net project an interdisciplinary approach was established at Bonn University to use innovative sensor technologies for plant stress detection. Using the expertise from phytopathology, geography, computer science and data mining, effective sensor methods will be brought forward for the monitoring of plant diseases. Based on the model system barley, and the foliar diseases net blotch (*Pyrenophora teres*), leaf rust (*Puccinia hordei*) and powdery mildew (*Blumeria graminis hordei*) spectral signatures were assessed with a hyperspectral VIS/NIR camera and with a hyperspectral SWIR camera from 400 to 2500 nm. The spectral data cubes were analysed by extracting specific spectral signatures of characteristic symptoms during pathogenesis. Advanced automatic classification methods were used for the differentiation and quantification of diseased leaf tissue with high accuracy. In a next step the developed models will be carried forward to other crop plants and their diseases. It is assumed, that hyperspectral sensing in combination with powerful data analysis methods will be of essential support for Integrated Pest Management programs for sustainable crop production. The effectiveness of crop protection actions will be optimized ecologically and economically by increased precision in both, time and space.