The detection of pest in the production of young ornamental plants with the use of reflectance spectroscopy

The health of young ornamental plants, which serve as the initial material for professional ornamental plant production, is crucial throughout the entire production process. Rapid identification of threats is essential, as young ornamental plants are particularly vulnerable to impaired growth and development caused by stress from pests and abiotic factors.

This study evaluated the usefulness of reflectance spectroscopy as a tool for detecting changes in young ornamental plants due to the impact of pests or abiotic stressors. The hypothesis was that the reflectance spectral characteristics of plants contain useful information for distinguishing healthy plants from those affected by pests and abiotic stress factors.

Spectral measurements were performed using a non-imaging method with an ASD spectroradiometer (FieldSpec Analytical Spectral Devices, Inc., Boulder, Colorado, USA) in two modes: contact and proximal. The study involved young ornamental plants from 8 species and 15 varieties, which were subjected, depending on the experimental setup, to one of three pests (*Botrytis cinerea* Pers., *Frankliniella occidentalis* Pergande, *Golovinomyces cichoracearum* (DC.) V.P. Heluta) or one of two abiotic stressors (excess water, water deficiency). The study employed a four-step procedure aimed at identifying wavelengths with discriminatory potential for specific stress factors and testing characteristic wavelength sets on the selected research subjects. Two signal transformation methods were used in data preprocessing: Baseline Alignment (BA) and Savitzky-Golay (SG).

The results indicate that the pressure of the stress factor leads to symptoms reflected in the spectral characteristics of plants. Based on changes in spectral characteristics, it was possible to determine characteristic wavelengths with discriminatory potential. The majority of wavelengths with discriminatory potential were most frequently selected from the 700–1440 nm range. The accuracy of diagnosis, based on the identified sets of wavelengths, depended on the type of stress factor, exposure time, and plant taxon, ranging from 54% to 100%. It was shown that diagnostic accuracy was lowest in the case of B. cinerea after two days of exposure. Increasing stress factor pressure led to more pronounced changes in spectral characteristics, but prolonged exposure to a stress factor causing extensive plant damage reduced diagnostic accuracy. Diagnostic wavelength sets for a given stress factor, determined based on research across multiple taxa, were found to be more universal than those identified from studies of a single taxon.

It was demonstrated that the wavelength sets enabling the differentiation of healthy plants or leaves from those showing symptoms caused by specific biotic (pests) and abiotic stress factors shared common features due to the plants' diverse and general response. It was found that distinguishing a single stress factor carries the risk of a false positive in the presence of another stress factor.

Both the BA and SG transformations were useful for processing raw spectral data. It was determined that the two transformations are complementary, and using both can reveal different features resulting from stress factor pressure.