

NON-INVASIVE OPTICAL SPECTROSCOPY IN PLANT STRESS RESEARCH: CIRCADIAN RHYTHM AS A DIAGNOSTIC MARKER

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ABSTRACT

In the context of environmental changes and the increasing demand for sustainable agricultural practices, real-time monitoring of plant health is increasingly important. This work provides an overview of the development and application of non-invasive optical spectroscopy for early detection of stress across a wide range of plant species. The approach combines high-resolution time tracking of leaf transmission with circadian rhythm analysis, allowing the identification of subtle physiological changes that precede visible stress symptoms.

This work presents results from several experimental studies, including hydroponically grown herbs, forest species, aquatic plants, ornamentals, and agricultural crops. The methodology enables early detection of stress caused by nutritional deficiencies, pathogenic infections, and sudden changes in light intensity. Integration of the 640 nm and 665 nm spectrum bands significantly improved system sensitivity, allowing precise characterisation of metabolic responses. These advances are supported by comprehensive metrological validation, which ensures the repeatability and robustness of the data under experimental conditions.

The lecture highlights circadian rhythm not only as a fundamental biological process, but also as a new diagnostic marker of the physiological state of the

plant. Through a variety of case studies and practical applications, we demonstrate how this optical platform contributes to improving understanding the response of plants to stress and offers new perspectives in plant science, forest monitoring, and precision agriculture.

Keywords: Non-invasive spectroscopy, Circadian rhythm, Plant stress detection, Real-time plant monitoring, Leaf transmittance.