AQUAPHOTOMICS FOR PRECISION AGRICULTURE

Roumiana Tsenkova, Jelena Muncan

Biotechnology Measurement Laboratory, Kobe University, Japan

ABSTRACT

The scientific field of aquaphotomics [1] has in the last two decades provided novel ways to characterize water, food, materials and provide disease detection and health monitoring of microorganisms, plants, animals and humans [2]. Aquaphotomics is established on the foundations provided by visible-near infrared (vis-NIR) spectroscopy, whose possibilities were furthered by the discovery that water molecular matrix in aqueous-biological systems behaves as a sensor. The water is a complex, interconnected molecular system composed of many molecular species with different functionalities, strongly influenced by all the components in it and physical fields. This high sensitivity of water hydrogen bonds to any perturbation is what makes it a perfect sensor to capture all intricacies of aqueous systems. The interaction of water and light, presented as spectra allows extraction of information which water-sensor registered. This is the basis of an innovative aquaphotomics measurement technology. Water spectral pattern, as an integrative marker/biomarker describes the state, properties and functionality of the examined aqueous/biological systems.

Vis-NIR spectroscopy, multi- and hyper-spectral imaging offer non-destructive, reagent-free, environmentally-friendly and rapid analysis of physical and chemical properties, even biological parameters of samples in diverse application fields. Portable technology and imaging systems allow measurements directly on-site and from remote locations. With the developments of aquaphotomics, the use of Vis-NIR spectroscopy has been growing rapidly both in number and complexity of measured properties. It is used in water and food quality control, non-invasive diagnostics and other health-related applications for different biological organisms.
The results obtained so far using vis-NIR point spectroscopy provided the evidence of practicality of aquaphotomics for the following applications (among many others): discrimination of soil types, assessment of chemical and biological parameters of the soil, detection of contamination and soil health monitoring; discrimination of seeds and assessment of seed viability, plant health monitoring and early detection of abiotic (cold stress, drought stress, pollution stress) and biotic stress, quality assessment and monitoring of plant-based food [3, 4]. It follows that as long as the analyzed system is aqueous, the same aquaphotomics-based measuring and analysis method can be used at every step of agricultural operations. The expansion of aquaphotomics principles into the fields of hyperspectral and multispectral imaging, can further the assessments on the level of the field and canopy and offer novel strategies for the development of modern precision agriculture that relies on real-time monitoring and feedback-based on-site management.

Index Terms— Aquaphotomics, near infrared spectroscopy, plant stress, monitoring, precision agriculture

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