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Editorial: Special issue on optical spectroscopy of plants and algae

The analysis of the light emitted by plants provides valuable insights for developing non-destructive methods to infer the physiological state of a plant and detect photosynthetic alterations. When light interacts with a plant or algae, some of the energy is reflected, some is transmitted, and another part is absorbed. The absorption of energy leads to electronically excited compounds. Of particular importance is the pair of chlorophyll-a molecules known as P680, associated with photosystem II, which from its excited state initiates the electron transfer that starts the photosynthetic electron transport chain. Concurrently, and in competition with photosynthesis, heat dissipation and fluorescence emission also occur.

Reflected, transmitted and fluorescence beams are closely interrelated and determine the optical properties of the photosynthetic organisms. Alterations in pigment content are usually manifested as changes in reflectance indexes or hyperspectral images whereas alterations in photosynthesis are better related to chlorophyll fluorescence emission that can then be used as organism stress indicator. Optical spectroscopy represents an efficient non-destructive diagnostic tool employed at different levels (e.g. on chloroplasts, leaves or canopies), from confocal microscopy to satellite detection, including sun-induced fluorescence (SIF). It finds application in the monitoring of microalgal cultivations or in precision agriculture for a sustainable management of crops, optimizing yields and quality of products. The chlorophyll fluorescence excitation screening method can estimate health-related compounds (e.g. polyphenols) present in leaf epidermises and fruit skins.

In the present special issue, to identify corn hybrids with high resistance to UV-B radiation, Jovanić et al. studied the effect of UVB-radiation on the leaf chlorophyll concentration and energy storability of five genetically different corn hybrids using chlorophyll fluorescence. The method allowed to identify the corn hybrids most resistant to UV-B radiation [1].

The use of nanoparticles in different applications is increasing daily, therefore, it is essential to understand the potential effects of these new materials on various living organisms. Torres et al. analyzed the interaction between carbon nanoparticles and the photosynthetic electron transport chain in *Cichorium intybus* plants, to assess whether these nanoparticles had a beneficial or toxic impact on the initial stages of photosynthesis. They found a deleterious effect on the performance of photosystem I, accompanied by a decrease in pigment content and a reduction in the xanthophyll cycle activity [2].

Climate change is causing an increase in the planet́s global temperature. This is particularly true for the oceans, leading to an increment in liquid water and a consequent decrease in salinity in the Artic. By using chlorophyll fluorescence analysis, Marambio et al. studied how the alga *Palmaria palmata* responded to changes in water salinity. They found that a decrease in salinity affected the algá s ability to effectively respond to variations in daily irradiance. The authors conclude that this effect may lead in the future to a decline in the Arctic populations of *P. Palmata*, or to the development of a low-salinity resistant ecotype [3].

Cordon et al. examined the effect of the herbicide Atrazine, incorporated in chitosan and alginate nanocapsules on *Cichorium intybus* plants, through the analysis of the fast transient of chlorophyll fluorescence [4].

Predicting ecosystem adaptation strategies is relevant for understanding ecosystem stability. Studying differences in photosynthesis between early and late successional trees provides valuable insights in this regard. Pollastrini et al. investigated, through chlorophyll fluorescence analysis, how photosynthesis rates and electron transport differentiated early successional (ES) and late successional (LS) plants within forest communities. They showed that LS tree species displayed a substantial regulation and stability of the photosynthetic machinery and photosystem stoichiometry, whereas ES species had more dynamic behavior of PSI [5].

Bryophytes constitute a group of non-vascular plants of great importance in ecosystems as primary colonizers of soil and providers of habitat and food for various organisms. Through the analysis of Chlorophyll fluorescence and the determination of defined biomarkers as proline and malondialdehyde, Bhatt et al. examined the photosynthetic performance of a particular bryophyte (*Riccia gangetica*) under various abiotic stresses: heat, cold, salinity, submergence and UV-B radiation [6].

Acebron et al. compared the photosynthetic activity of a green soybean (Glycine max L.) cultivar (Eiko) and a chlorophyll-deficient mutant (MinnGold) under dynamically fluctuating light conditions. The aim was to test if Chl-deficient plants under fluctuating light conditions presented a slower adjustment of the photosynthetic light energy harvesting causing lower field productivity. Their physiological observations combined with fluorescence kinetics could be used to parameterize chlorophyll content in modeling of chlorophyll fluorescence and plant productivity [7].

Chaves Oliveira et al. employed chlorophyll fluorescence analysis to investigate the impact of precipitation patterns on trace element concentrations deposited along the coast from ore tailings released during the Mariana disaster in Brazil. They focused on how these elements (Cu, Mn, Fe, Zn) affected photosynthesis in *Byrsonima sericea*, a shrub species typical of restinga ecosystems [8].

The study of protective agents against UV radiation in photosynthetic organisms is highly relevant. Meichssner et al. studied brown algae using fluorometric methods to determine to what extent and in which region of the wavelength spectrum the epidermal layer of

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physodes (phlorotannin-rich vesicles) in two species of *Fucus* reduces UV radiation transmission. For comparison, they also examined *Saccharina latissima*, a brown algal species lacking this epidermal physode layer. Additionally, they explored the correlation between variations in UV transmission and responses of photosystem II stress under artificial UV-B illumination [9].

Marine algae are relevant in the environment due to their photosynthetic function and contribution to nutrient cycling, as well as their role in feeding various animals. Their biomass has great potential for biotechnological applications and understanding their physiological characteristics is essential for maximizing productivity in cultivation systems. Martins et al. reviewed the photosynthetic characteristics of marine algae, emphasizing their significance in biotechnology [10].

The collection of articles in this special issue exemplifies the powerful message conveyed by the light emitted from plants and algae, particularly chlorophyll fluorescence. Through this silent language, they provide us with information not only about the state of the organism and alterations in its photosynthetic apparatus, but also about CO_2 uptake and the presence of environmental stress factors.

We thank the authors who contributed to this issue and hope that audience will enjoy the reading experience.

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