Optical sensors for vine water status monitoring

Pampuri A.*[1], Tugnolo A. [1], Giovenzana V. [1], Beghi R. [1], Fontes N.[2], Oliveira H. M.[3], Casson A. [1], Guidetti R. [1]

1 Department of Agricultural and Environmental Sciences - Production, Landscape, Agroenergy, Università degli Studi di Milano, via Celoria 2, 20133, Milano, Italy

2 Sogrape Vinhos, S.A., Aldeia Nova, Avintes, Portugal

3 INL, International Iberian Nanotechnology Laboratory, Braga, Portugal

*Corresponding Author contacts: alessia.pampuri@unimi.it, +390250316874

Keywords. Grapevine, optical device, green technology, vis/NIR spectroscopy, chemometrics.

Abstract. The selection of resistant genetic material, the use of cover crops, and the delivery of water through irrigation are all agronomic strategies for water management in the vineyard. Indeed, irrigation is becoming an important method in various viticultural zones to support production and maintain grape quality. Precision irrigation is a viable technique for improving water management: it optimizes water delivery over time and space, boosting water use efficiency at the field scale. The introduction of innovative technology provides for increased efficiency and quality of production while simultaneously lowering environmental effect. The plant water status is the most important metric for evaluating and managing irrigation techniques.

Water potential (Ψ) has been regarded as a relevant and repeatable indicator of plant water status. Measuring water potential necessitates destructive sampling, which is labor-intensive, time-consuming and subject to operator bias. The employment of optical-based methodologies that are non-destructive and reproducible on a wide scale for entirely networked IoT device development is one of the most promising approaches to break these present methodological constraints.

This study focuses on the definition of optical specifications for the construction of cost-effective sensors. The sampling was carried out on Pinot Blanc cv. grapes: optical data was acquired on leaves. The correlation between predawn water potential (Ψ_{PD}) and moisture content was examined using Pearson's correlation analysis ($r = 0.47$ and $p\text{-value}<0.05$), revealing a low correlation between the two metrics. The optical data (350-2500 nm) were used to create a PLS-model to estimate Ψ_{PD} (RMSEP = 0.056 MPa, $R^2 = 0.7$).

The most important wavelengths selected by VIP-scores procedure were used to calibrate another chemometric model (an RMSEP = 0.056 and an $R^2 = 0.60$). These results paved the way for the creation of more integrated optical sensors that can monitor vine water condition in the field in a distributed and autonomous fashion.