Combination of NIR multispectral information acquired from a ground moving vehicle with AI methods to assess the vine water status in a Tempranillo *(Vitis vinifera* L.) commercial vineyard.

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Abstract (250 words)

Increasing water scarcity and unpredictable rainfall patterns necessitate efficient water management in grape production. This study proposes a novel approach for monitoring grapevine water status in a commercial vertically-shoot-positioned Vitis vinifera L. Tempranillo vineyard using non-invasive spectroscopy with a battery of different AI methods to assess vineyard water status, that could drive precise irrigation. A contactless, miniature NIR spectrometer (900-1900 nm) mounted on a moving vehicle (3 Km/h) was employed to collect spectral data from the vines' northeast side along six dates in season 2021.Grapevines were monitored at solar noon using stem water potential (Ψs) as reference parameter of plant water status. At each date, 36 measurements of Ψs were taken making a total of 396 data in the whole season. AI techniques, including linear regression, gaussian process regression (GPR) support vector machine (SVM), and neural networks, trained with Levenberg-Marquardt (LM) and Scaled Conjugate Gradient (SCG) algorithms were implemented in MATLAB (using the Regression Learner and Natural Net Fitting apps) to analyze the spectral data and predict vine water status. The optimized GPR model achieved the best performance, with a determination coefficient (R^2_P) above 0.83 and a root mean squared error of prediction ($RMSE_P$) of 0.112 MPa. However, several neural network models trained with the LM algorithm exhibited superior performance, with R^2_P values over 0.92 and $RMSE_P$ values of approximately 0.080 MPa. This study demonstrates the potential of non-invasive spectroscopy combined with AI methods for accurate prediction of grapevine water status, paving the way for precision irrigation in vineyards.

Keywords: Vine water status, NIR spectrophotometer, Stem water potential, Gaussian Regression Process, Levenberg-Marquardt algorithm