Hyperspectral imaging and machine learning for monitoring grapevine physiology

Prakriti Sharma[1], Anne Fennell[1*]

[1] *South Dakota State University, Brookings SD, USA*

[*] *Corresponding author: anne.fennell@sdstate.edu**

Rootstocks are gaining importance in viticulture as a strategy to combat abiotic challenges, as well as enhancing scion physiology and attributes. Therefore, understanding how the rootstock affects photosynthesis is insightful for genetic improvement of either genotype in the grafted grapevines. Photosynthetic parameters such as maximum rate of carboxylation of RuBP (V_{cmax}) and the maximum rate of electron transport driving RuBP regeneration (J_{max}) have been identified as ideal targets for breeding and genetic studies. However, techniques used to directly measure these photosynthetic parameters are limited to the single leaf level and are time-consuming measurements. Hyperspectral remote sensing uses the optical properties of the entire vine to predict photosynthetic capacity at the canopy level. In this study, estimates of V_{cmax} and J_{max} were assessed, in six different rootstocks with a common scion, using direct measurements and canopy reflectance obtained with hyperspectral wavelengths (400 to 1000 nm). Using artificial intelligence-based modeling, prediction models were developed for Marquette on the six different rootstock genotypes. Results for direct and indirect measures indicate that each rootstock promotes differences in scion V_{cmax} and J_{max} profiles across the season. Application of machine learning and neural networks of spectral data provided good predictions of both photosynthetic parameters.

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