Hyperspectral imaging and machine learning for monitoring grapevine photosynthesis

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January 14, 2023

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Keywords: hyperspectral, machine learning, grapevine, photosynthesis

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 (Vcmax) and the maximum rate of electron transport driving RuBP regeneration (Jmax) has been identified as ideal targets for breeding and genetic studies. However, techniques used to measure these photosynthetic parameters are time consuming and subjective to leaf level which is complex to implement at field scale. Hyperspectral remote sensing uses the optical properties of the entire vine to predict photosynthetic capacity at canopy level. In this study, estimates of Vcmax and Jmax were assessed using different machine learning models: PLS (Partial least Squares), LR (Least Angle Regression), LASSO (Least Absolute Shrinkage and Selection Operator), PCR (Principle Component Regression) based on leaf reflectance metrics obtained with hyperspectral wavelength ranging from 400 to 1000nm. Prediction models were developed for six different rootstock genotypes with common scion Marquette considering three different sampling dates carried out in Brookings, South Dakota in 2021. Preliminary results indicate that each rootstock has distinctly different Vcmax and Jmax profiles across the season. From the model assessment, PLS was found to have robust prediction of Vcmax with R2 of 0.53 and for Jmax with R2 of 0.63. Multiple year trials will be used to validate precise and rapid quantification of photosynthesis using hyperspectral remote sensing.