Oral presentations

Dissecting foliar physiology and chemical properties with integrated high-throughput phenotyping and molecular markers in grape improvement

Ikeogu, Ugochukwu[1*]; Gold, Kaitlin M.[2]; Couture, John[3]; Gambhir, Nikita[2]; Simangunsong, Robetauli[2]; Sapkota, Surya[2]; Colizzi, Michael[1]; Cadle-Davidson, Lance[2,4]; Reisch, Bruce[1]

[1]Cornell University, Cornell-AgriTech, Horticulture Section, Geneva, NY, USA

[2]Cornell University, Cornell-AgriTech, Plant Pathology & Plant-Microbe Biology Section, Geneva, NY, USA

[3]Purdue University, Depts of Entomology and Forestry and Natural Resources, West Lafayette, IN, USA

[4]USDA-ARS, Grape Genetics Research Unit, Geneva, NY, USA

*uni3@cornell.edu

Abstract

As advances in sequencing technology continue to reduce the time and cost of generating genome-wide genotypic data, the need to develop complementary efficient technologies to likewise increase phenotyping throughput non-destructively and cost-effectively has become imperative in plant breeding. Hyperspectral reflectance, acquired by either imaging or non-imaging spectrometers, measures the interaction of light with vegetation at single leaves or entire canopy. This technology can be used to detect structural, chemical, and functional traits useful in accelerating crop breeding. We deployed a portable field spectroradiometer (SVC-HR1024i) with a wavelength range of 350 nm to 2500 nm to acquire grapevine foliar spectral signatures to improve our phenotyping throughput of foliar chemical and physiological properties including pigments, phenolics, flavonoids, sugars, and to better understand the variations, genetic architecture, and correlations with yield, fruit quality, vine health, and nutrition. Data were collected in Cornell University Grape Breeding Program mapping populations and the diverse genetic collection of the USDA Plant Genetic Resources Unit in Geneva, NY. Preliminary results regarding the accuracy of using the hyperspectral device as an alternative analytical tool for leaf chemical attributes, developed using Partial Least Square regression, showed a correlation between actual and predicted values of 0.46 to 0.99 in the training population (n~79 samples) and 0.28 to 0.63 in the test set (n~32) for leaf pigments – Neoxanthin, Violaxanthin, Lutein, Zeaxanthin, Chlorophyll a, Chlorophyll b and Beta-Carotene. Combined with publicly available resources (foliar prediction models in several other plants from the Ecological Spectral Model Library, ecosml.org), we are exploring QTL associated with phenotypic variation in grape foliar traits and hope to further understand how they relate to fruit quality, vineyard health, and nutrition. As more data points become available and using advanced machine learning models, integrating high-throughput spectral phenomics will help to facilitate the simultaneous improvement of leaf physiological and chemical composition of grape, complementing ongoing efforts to improve disease resistance, other biotic as well as abiotic stress resistances, fruit quality traits and yield.

Keywords: grapes, breeding, high-throughput phenotyping, hyperspectral, QTL