How sensor technologies combined with artificial intelligence increase the efficiency in grapevine breeding (research): current developments and future perspectives

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Abstract (250 words)

Viticulture and grapevine breeding programs have to face and adapt to the rapidly changing growing conditions due to the ongoing climate change, the scarcity of resources and the demand for sustainability within the whole value chain of wine production. In times of highly effective and cost-efficient genotyping technologies routinely applied in plant research and breeding, the need for comparable high-speed and high-resolution phenotyping tools has increased substantially. The disciplines of grapevine research, breeding and precision viticulture picked up this demand – mostly independent from each other – by the development, validation and establishment of different sensor technologies in order to extend management strategies or to transform labor-intensive and expensive phenotyping.

Although aims, usage and expenses of applying digital tools differ, the requested outcome is similar: objective, precise and reliable data for plant evaluation with high spatial and temporal resolution. For grapevine research and breeding, fast and possibly non-destructive data acquisition is crucial in order to capture phenotypic behaviors throughout the season, e.g. plant health after heat waves (grape sunburn). Depending on the trait of interest, we established pipelines for high-throughput data acquisition under standardized lab conditions and for in-field applications by ground-based platforms. Automated data analysis is furthermore of outstanding importance to reliably extract phenotypic traits from sensor data without the need of permanent user interaction. Therefore, efficient sensors combined with AI-based data analysis are the most powerful tools we used to extract and predict complex traits like yield potential, canopy health (both using field images) or *Botrytis* bunch rot resilience.

Keywords: High-throughput phenotyping, digital trait detection, yield prediction, grapevine health, quantitative trait locus (QTL) analysis.