High-resolution aerial thermography for water stress estimation in grapevines.

Carlos Poblete-Echeverria[1*], Thomas Chalmers[1], Melane A. Vivier[1]

[1] South African Grape and Wine Research Institute (SAGWRI), Faculty of AgriSciences, Stellenbosch University, Matieland 7602, South Africa

*[*]Corresponding author: cpe@sun.ac.za**

Abstract

Aerial thermography has emerged as a promising tool for water stress detection in grapevines, but there are still challenges associated with this technology, particularly concerning the methodology employed to extract reliable canopy temperature values. This consideration is relevant especially in vertically trained vineyards, due to the presence of multiple surfaces which are captured by drone thermal cameras with high-resolution. To test the technology and the data analysis required, a field study was conducted during the 2022-2023 season in a model vineyard with multiple scions-rootstock combinations trained on a vertical shoot-positioning (VSP) system. Additionally, three irrigation regimes were implemented to introduce variability in water stress levels. A commercial Unmanned aerial vehicle (UAV) equipped with an integrated RGB, and thermal camera was used to capture high-resolution aerial images over the vineyard. Eight different pixel extraction methods, considering classical and novel approaches, were tested against manual pixel extraction to determine which method performed the best. From the methods tested, the two Gaussian mixture models (GMM2) showed the best performance in terms of accuracy and precision. The average canopy temperature obtained by this method was contrasted with stem water potential measurements, showing significant differences between well-watered and dryland treatments. Aerial thermography complemented by the GMM2 method shows great potential as a tool for water stress estimation in grapevines, however, several factors play a role in method performance. These include the degree of stress in the vineyard, amount of cover crops, and canopy density amongst others. Suggestions regarding the critical aspects that need to be evaluated further to optimize the methodology and reduce the uncertainties associated to the application of this technology will be discussed in context of the results obtained.

Keywords: Precision viticulture, Water management, Digital analysis, Pixel extraction methods, Thermal imagery.