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Soil apparent electrical conductivity and must carbon isotope ratio provide indication of plant water status in wine grape vineyards

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Proximal sensing is being integrated into vineyard management as it provides rapid assessments of spatial variability of soils' and plants' features. The electromagnetic induction (EMI) technology is used to measure soil apparent electrical conductivity (EC_a) with proximal sensing and enables to appraise soil characteristics and their possible effects on plant physiological responses. This study was conducted in a micro irrigated Cabernet Sauvignon (Vitis vinifera L.) vineyard to investigate the technical feasibility of appraising plant water status and its spatial variability using soil EC_a and must carbon isotope ratio analysis ($\delta^{13}C$). Soil temperature and soil water content were monitored in-situ using time domain reflectometry (TDR) sensors. Soil EC_a was measured with EMI at two depths [0 – 1.5 m (deep EC_a) and 0 – 0.75 m (shallow EC_a)] over the course of the crop season to capture the temporal dynamics and changes. At the study site, the main physical and chemical soil characteristics, i.e. soil texture, gravel, pore water electrical conductivity (EC_e), organic carbon, and soil water content at field capacity, were determined from samples collected auguring the soil at equidistant points that were identified using a regular grid. Midday stem water potential (Ψ_{stem}) and leaf gas exchange, including stomatal conductance (g_s), net carbon assimilation (A_n), and intrinsic water use efficiency (WUE_i) were measured periodically in the vineyard. The $\delta^{13}C$ of produced musts was measured at harvest. The results indicated that soil water content (relative importance = 24 %) and texture (silt: relative importance = 22.4 % and clay: relative importance = 18.2 %) were contributing the most towards soil EC_a. Deep soil EC_a was directly related to Ψ_{stem} (r^2 = 0.7214) and g_s (r^2 = 0.5007). Likewise, $\delta^{13}C$ of must was directly related to Ψ_{stem} (r^2 = 0.9127), g_s (r^2 = 0.6985), and A_n (r^2 = 0.5693). Results from this work provided relevant information on the possibility of using spatial soil EC_a sensing and $\delta^{13}C$ analysis to infer plant water status and leaf gas exchange in micro irrigated vineyards.