NOVEL PROTOCOLS FOR VARIABLE RATE VINEYARD MANAGEMENT

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Abstract:

Context and purpose of the study – The advent of precision viticulture (PV) has allowed to address problems related to spatial and temporal variability at the within-field scale. Nowadays, several remote and proximal sensing solutions allow description of the existing variability at different temporal and ground resolution through extremely robust soil, vigor, yield, and grape quality maps. In parallel, numerous studies have described grapevine performances within the homogeneous zones and identified soil as main driver of variability. There is a broad consensus that different vigor zones within the same plot may show differential canopy growth, yield and fruit composition, depicting diverse enological potentials and cultural needs. Indeed, within-field variability reduces the efficiency of traditional vineyard management paving the way to a site-specific approach. However, despite a large availability of enabling technologies and potential agronomical applications, few examples of fully automated protocols assisted by variable rate (VR) technologies are now implemented in viticulture. The review paper has a triple goal: a) describe recent advances in PV relying upon the use of spatial data; b) address the physiological background and economic convenience of operational protocols concerning variable management of some key cultural practices, and c) foster the acceptance of VR practices by grape growers.

Material and methods – The study will compare traditional and novel vineyard management protocols aiming at exploiting or correcting the existing variability towards optimal vigor. In detail, the paper will focus on: a) defining a management strategy to reduce vineyard variability as based on VR applications for improving use of resources, enhancing productivity and fruit quality, and reducing environmental impacts; b) reducing chemicals through on-the-go adjusted pesticide sprays depending on actual vigor; c) exploiting within-field variability through selective harvesting (SH) for a consequent product diversification and increased revenue.

Results – VR application of the prompt-effect urea fertilizer reduced spatial variability over four years. A Controlled Release Fertilizer (CRF) allowed faster responses in low vigor zones fostering desired increasing in total leaf area and yield. On the contrary, fertilization in high and medium vigor zones did not differ to the not fertilized Control demonstrating that fertilization was not required. VR application of CRF improved efficiency of vineyard fertilization and reduced N-waste with a fertilizer saving up to 33%. However, indirect benefits related to a more homogeneous vineyard are considered to be much more promising. A variable rate drip irrigation (VRDI) allowed to reduce vegetative and yield heterogeneity leading to 20% water saving and 17% more production. When VRDI was stopped in favor of traditional irrigation, a pattern of variability similar to pre-trial status was observed. VR-spray application allowed significant saving of pesticide solution vs. Control, maintaining similar application efficiency in terms of canopy coverage, spray penetration and ground deposit. Furthermore, VR did not affect disease infections, yield and fruit composition. Both manual and mechanical selective harvesting performed at the same time or in separate events can exploit vineyard variability, and grapes from the same parcel used for producing distinct wine styles. Ground-truthing of the vigor map becomes crucial as quality zones segmentation may vary depending on vineyard attributes and actual vigor. Seasonal feasibility and insights on economic convenience of SH are also discussed.

Keywords: Optimal Vigor, Variable Rate Applications, Fertilization, Selective Harvesting, Profitability