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Editorial on the Research Topic

Biogeosciences and Wine: The Management and Environmental Processes That Regulate the Terroir Effect in Space and Time

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Viticultural terroir is formally defined by the International Organization of Vine and Wine (OIV, 2010) as "*a concept which refers to an area in which collective knowledge of the interactions between the identifiable physical and biological environment and applied vitivinicultural practices develops, providing distinctive characteristics for the products originating from this area*". Though the OIV's definition does mention neither the time perspective inherent with terroir shaping nor its facet of cultural inheritance, which are important aspects, the study of terroir includes multidisciplinary approaches accounting for soil, geomorphology, morphometry, climate, as well as vineyard management, grapevine genotypes, historical know-how, and experiments, in addition to oenological practices (Deloire et al., 2005; Van Leeuwen and Seguin, 2006; Vaudour et al., 2015). However, time-rooted scientific questions about sustainability, the resilience of the vineyard system (Vaudour et al., 2017; Bonfante et al., 2018; Costantini et al., 2018), efficiency, and traceability have recently emerged. This Research Topic groups several innovative studies about these key issues and the approaches that were carried out for studying the terroir as a complex system, especially under climate change.

In the opinion paper, Brillante et al. critically examine the improper but popular use of the terroir concept, rejecting an implicit sensorial superiority for terroir wines and suggesting future directions for science in this field, with a focus on viticulture zoning. The authors stress the importance of characterizing and understanding the spatial variability of vineyards and the effects on grapevine physiology and grape composition independently from the price range of wines and connect the bio-physical study of terroir to precision viticulture.

The perspective from White summarizes the actual knowledge about the effects of soil characteristics on the grapevine, and then wine, concluding that most of these relationships are dependent on individual grape cultivars and individual sites. Therefore, site-specific studies, are needed to comprehend the soil effect on the specific wine. Soil health and microorganisms are the focus of the review from Lazcano et al., collecting the main results of studies on sustainable management practices, namely cover cropping and composting, in vineyards. The authors propose to include in the "terroir concept", the dynamic aspects of soil health driven by soil organic matter

and soil biota which may influence vine performance, and potentially affect wine quality. The paper of Mocali et al. moves one step forward in this direction, with the results from a case study in Chianti Classico (Italy) where two near plots, within a single vineyard, showed very similar soil physical and chemical features, but different wines. The authors were able to link wine composition to sulfur-oxidation genes in the soil and to highlight the potential role of sulfur metabolism as determining co-factor in the vineyard-scale variation of grape characteristics.

Such site-specific approach is also supported by the paper of Yu and Kurtural. The authors report a case study of mapping grapevine stem water potential (Ψ_{stem}) and soil apparent electrical conductivity (*ECa*) within a vineyard in California. They found a good relationship between the spatial variability of ECa and Ψ_{stem} and they tested selective grape harvest in two statistically different zones of the vineyard. The two zones produced wines characterized by different amounts and quality of anthocyanins. Similar results were also reported by the paper of Yu et al., which describes a two-year case of study in a different area and also assesses the effects of vineyard variability on wine composition. An alternative method to map grapevine water stress and delineate homogeneous zones for selective harvest is proposed by Brillante et al. The authors use the carbon stable isotope composition ($\delta^{13}C$) of grape juice at harvest to capture the spatial variability of physiological response at the vineyard scale and then compare the efficacy of separating grape composition with this zoning technique respect to zoning obtained with traditional measurements (pressure chamber) and modern sensors (soil ECa, canopy reflectance). This article also shows tight correlations between Ψ_{stem}, leaf gas exchange, and $\delta^{13}C$ across multiple varieties and vineyard regions.

Vineyard variability is generally investigated at the soil and plant level, but Bois et al. present a very original paper on mapping rainfall variability at a local scale using a dense rain-gauge network composed of 45 sensors over a 28 km^2 area. They used the rainfall data as an input variable in a soil water balance model to understand the impact of rainfall variability on water available to plants and showed how local rainfall might contribute to change in grapevine water status as large as 50% of the simulated regional water balance spatial variability. Considering the relevance of understanding the effect of climate change on terroir systems, De Resseguir et al. present a very high-resolution mapping of temperature at the local scale (19,233 ha) across six different seasons. Their maps show an amplitude of up to 10°C in a given day, and 320 degree days in the Winkler index in the Bordeaux area. They complement these maps with phenological observations to inform strategies for adaptation of plant material and cultural practices to local temperature variability and change. Relationships between temperature and grapevine phenology are also investigated by Merrill et al., with a focus on assessing the effect of high temperatures during flowering in a controlled-environment experiment with 50 varieties. Their research is combined with a review of the studies of controlled warming on winegrape varieties.

Another important aspect investigated in this RT is the use of plant biostimulants, addressed in the paper of Cirillo et al. These authors studied this rising and environmentally friendly practice on *Vitis vinifera* L. cv 'Aglianico' in southern Italy, investigating the possibility to apply a biostimulant derived from tropical plant extracts to improve the defenses of grapevine. Biostimulants mitigate possible negative effects of reducing the use of chemicals suitable for pest and disease management. Foliar applications of biostimulant appeared to induce a different response depending on the environmental factors and on the oxychloride copper dose distributed.

This RT also includes a research paper by Tescione et al. on the use of Sr isotopic ratio ($^{87}Sr/^{86}Sr$) as a geochemical tracer of white wines. The paper shows that the $^{87}Sr/^{86}Sr$ isotopic ratio of the geological substratum and soil is preserved in the must, and then in the wine, with no contribution given by the addition of bentonite and yeast using during the white wine-making process. Therefore it can be a promising method to trace the geographic provenance of white wines.

AUTHOR CONTRIBUTIONS

SP coordinated the editorial writing, all authors contributed to writing and revision, and approved the submitted version.

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