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Soil hydraulic properties and slope steepness: What does play the dominant role in vine water stress? A case study on “Aglianico” vineyard grow in a Mediterranean area

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Grapevine is well adapted to Mediterranean climate where it is commonly cultivated along the slopes in hilly areas.
The soil is a primary factor of terroir. Soils with limited water holding capacity can bring to vine water stress, which affects grape and wine quality. Along the slope, heterogeneity of soil physical properties and water flow can allow better soil water status in down- than up-hill soil. In the literature, discrimination between these two factors is often only qualitatively addressed and differences in grape and wine quality between down- and up-hill soil are often attributed to a generic “slope effect”.
Our aim is to discriminate in a vineyard grown along slopes, the role played by the hydraulic properties from the topographic characteristics in producing differences in soil water availability and therefore differences in grapevine water status, which, in turn, affects physiological responses, growth, yield and grape/wine quality.
The experimental site was an “Aglianico” vineyard grown along a 90 m slope (17.7 %) in a hilly area of the Mediterranean environment. The two soil sites, Cambic Calcisol (Up-hill) and Eutric Cambisol (Down-hill), had similar clay loam texture with different hydrological properties. Soil and vine water status, leaf gas exchanges and fluorescence, leaf area index, yield, and grape and wine quality were measured in the up- and down-hill side of the slope in two consecutive years. Hydrus-2D model was used to simulate water flow along the slope to estimate water status in the soil-plant-atmosphere continuum by using the two-year climate data set. We compared the model outputs for the two soil sites with the field experimental measurements. Finally, in order to quantify the effect of the slope steepness on the soil water balance of the two soils, the model was applied to simulate water flow with and without slope.
Down-hill soil had higher both soil matric potential and water content than Up-hill soil. Vines at bottom of slope had better leaf water status and higher gas-exchanges rate, photosynthetic efficiency, leaf area index and grape yield than vines at the top. On the contrary, quality of both grape and wine were enhanced in the more stressed up-hill than down-hill vines. Along the two years, Hydrus-2D simulations showed higher soil water availability in the Down- than the Up-hill soil. This result was predominantly caused by the different hydraulic properties between the two site soils, whereas the estimated contribution of both superficial runoff and lateral infiltration (inside soil) along the slope was negligible.
In conclusion, the “slope effect” on the soil water status and consequently on the vineyard behaviour, was mainly dominated by soil hydraulic properties rather than the steepness of the slope.