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Effects of inter-annual climate variability on grape harvest timing in rainfed hilly vineyards of Piedmont (NW Italy)

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Historical weather data represent an extremely precious resource for agro-meteorology for studying evolutionary dynamics and for predictive purposes, to address agronomical and management choices, that have economic, social and environmental effect. The study of climatic variability and its consequences starts from the observation of variations over time and the identification of the causes, on the basis of historical series of meteorological observations. The availability of long-lasting, complete and accurate datasets is a fundamental requirement to predict and react to climate variability. Inter-annual climate changes deeply affect grapevine productive cycle determining direct impact on the onset and duration of phenological stages and, ultimately, on the grape harvest and yield. Indeed, climate variables, such as air temperature and precipitation, affect evapotranspiration rates, plant water requirements, and also the vine physiology. In this respect, the observed increase in the number of warm days poses a threat to grape quality as it creates a situation of imbalance at maturity, with respect to sugar content, acidity and phenolic and aromatic ripeness.

A study was conducted to investigate the relationships between climate variables and harvest onset dates to assess the responses of grapevine under a global warming scenario. The study was carried out in the “Monferrato” area, a rainfed hillslope vine-growing area of NW Italy. In particular, the onset dates of harvest of different local wine grape varieties grown in the Vezzolano Experimental Farm (CNR-IMAMOTER) and in surrounding vineyards (affiliated to the Terre dei Santi Cellars) were recorded from 1962 to 2019 and then related to historical series of climate data by means of regression analysis. The linear regression was performed based on the averages of maximum and minimum daily temperatures and sum of precipitation (1962–2019) calculated for growing and ripening season, together with a bioclimatic heat index for vineyards, the Huglin index. The climate data were obtained from two data series collected in the Experimental farm by a mechanical weather station (1962-2002) and a second series recorded (2002-2019) by an electro-mechanical station included in Piedmont Regional Agro-meteorological Network. Finally, a third long-term continuous series covering the period from 1962 to 2019, provided by Italian Meteorological Society was considered in the analysis.

The results of the study highlighted that inter-annual climate variability, with a general positive trend of temperature, significantly affects the ripening of grapes with a progressive anticipation of the harvest onset dates. In particular, all the considered variables excepted precipitation, resulted negatively correlated with the harvest onset date reaching a high level of significance (up to $P< 0.001$). Best results have been obtained for maximum temperature and Huglin index, especially by using the most complete dataset. The change ratios obtained using datasets including last 15 years were greater (in absolute terms) than results limited to the period 1962-2002, and also correlations have greater level of significance. The results indicated clearly the relationships between the temperature trend and the gradual anticipation of harvest and the importance of having long and continuous historical weather data series available.