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Grapevine Phenology in Four Portuguese Wine Regions: Modeling and Predictions

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Phenological models applied to grapevines are valuable tools to assist in the decision of cultural practices related to winegrowers and winemakers. The two-parameter sigmoid phenological model was used to estimate the three main phenological stages of the grapevine development, i.e., budburst, flowering, and veraison. This model was calibrated and validated with phenology data for 51 grapevine varieties distributed in four wine regions in Portugal (Lisboa, Douro, Dão, and Vinhos Verdes). Meteorological data for the selected sites were also used. Hence, 153 model calibrations (51 varieties × 3 phenological stages) and corresponding parameter estimations were carried out based on an unprecedented comprehensive and systematized dataset of phenology in Portugal. For each phenological stage, the centroid of the estimated parameters was subsequently used, and three generalized sigmoid models were constructed (budburst: $d = -0.6$, $e = 8.6$; flowering: $d = -0.6$, $e = 13.7$; veraison: $d = -0.5$, $e = 13.2$). Centroid parameters show high performance for approximately 90% of the varieties and can thereby be used instead of variety-specific parameters. Overall, the RMSE (root-mean-squared-error) is < 7 days, while the EF (efficiency coefficient) is > 0.5 . Additionally, according to other studies, the predictive capacity of the models for budburst remains lower than for flowering or veraison. Furthermore, the F-forcing parameter (thermal accumulation) was evaluated for the Lisboa wine region, where the sample size is larger, and for the varieties with model efficiency equal to or greater than 0.5. A ranking and categorization of the varieties in early, intermediate, and late varieties was subsequently undertaken on the basis of F values. In this way, these results of the present study will be incorporated on a web platform, where the sigmoid model must convey valuable information regarding the development/evolution of the vineyard with short-term predictions.

Keywords: grapevine; phenology modeling; sigmoid model; wine regions; short-term predictions; Portugal

