Adapting grapevine varieties to climate change: can the genetic variability meet the challenge?

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Introduction

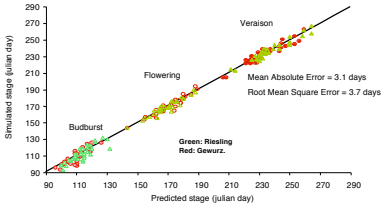
As for many species, climate change has already accelerated phenological stages for grapevine. We have shown that dates of véraison (onset of ripening) have advanced by more than three weeks in Alsace since the beginning of the 70s (Duchêne *et al*, 2005), and consequently, average temperatures during the ripening period have increased by more than 3°C over 30 years. Empirical knowledge more than experimental data suggest that high temperatures during berry maturation are detrimental to wine quality. In this study, our purpose was i) to assess what could be the advance in grapevine phenological stages in the future in Alsace, ii) what could be the consequences on temperatures during the ripening process and finally iii) to determine which type of variety could be adapted to these forecasted conditions.

Material and methods

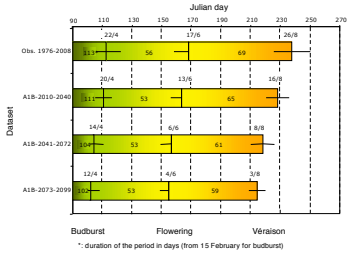
A model for predicting budburst, flowering and veraison dates was developped using 33 years of phenological stages recorded on gewurztraminer and riesling at Bergheim (68). This model is based on degree.days calculated with maximum temperatures using different base temperatures according to the period: 2°C for 15 February to 50% budburst, 10°C for 50% budburst to 50% flowering and 6°C for 50% flowering to 50% véraison (Duchêne *et al*, 2010).
This model was used to predict dates of budburst, flowering and véraison for Gewurztraminer and Riesling according to the greenhouse gas emissions scenarii A2, B2 and A1B. Projected climate data for Colmar were obtained through the regionalised general circulation model ARPEGE- Climat.
This model was also used to evaluate the genetic variability of phenological parameters on 120 genotypes of progeny from a Riesling ×Gewurztraminer cross, along with 14 European varieties, all of them grown in the experimental vineyard in Bergheim (68).

Results

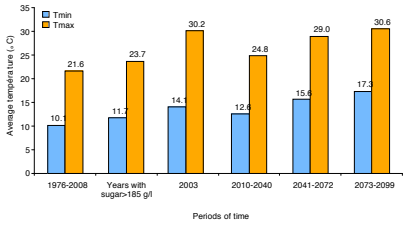
The model based on degree-days allows a good prediction of phenological stages



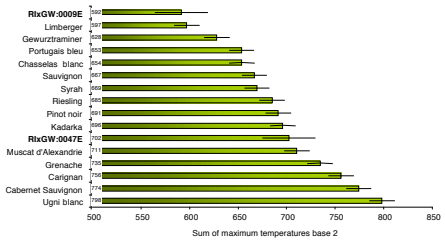
Phenological stages should keep on advancing (Colmar, riesling)



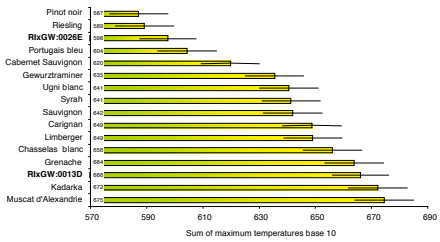
…and temperatures during ripening should continue to increase (Colmar, riesling, scenario A1B)



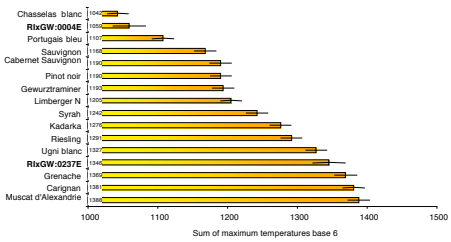
There is a genetic variability of the heat sums between 15 February and budburst



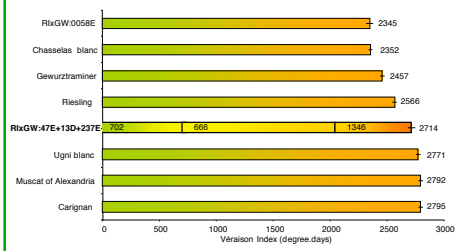
…, for the heat sums between budburst and flowering,



…and for the heat sums between flowering and véraison.

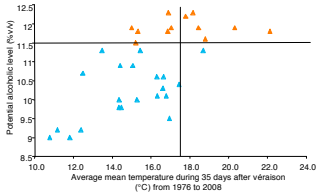


We can imagine to breed a new genotype with a late véraison date on the basis of the values observed in the progeny. This genotype should start to ripen after Riesling and a few days before Muscat of Alexandria



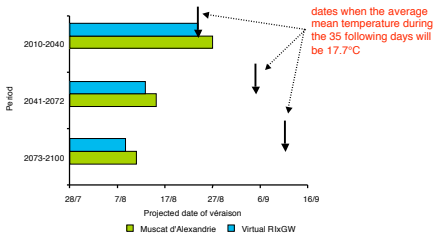
What is the temperature during ripening to be used to compare the impacts of climate change?

Example for Riesling: the average mean temperature during ripening was 17.7°C for the years where the sugar content was above 185 g/l *i.e.* 11.5 %, potential alcohol, level required in the Grand Cru vineyards.



Projected dates of véraison (A1B) compared to ripening temperatures.

Interpretation: during the 2041-2072 period, Muscat of Alexandria, or our virtual RIxGW child, should start to ripen around 15 August whereas to ripen under temperatures comparable to what we currently observe in the favourable years, véraison should occur around 5 September.



Conclusion

Compared with its timing in 1976-2008, véraison is predicted to advance by up to 23 days and mean temperatures during the 35 days following véraison are projected to increase by more than 7°C by the end of the twenty-first century for both varieties. Such changes will likely have a significant impact on grape and wine quality. We created a virtual late ripening genotype, derived from a cross between Riesling and Gewurztraminer. This modelled genotype was projected to undergo véraison 2-3 days before Muscat of Alexandria, one of the latest ripening varieties studied. Even with this virtual genotype, or with Muscat of Alexandria, grapes would ripen by the middle of the twenty-first century under higher temperatures than in the present years. Further research on the adaptation of grapevine varieties to climate change should not only consider developmental stages but also the ability of varieties to produce high quality wines under warm ripening conditions.

References

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