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Viticulture in a changing climate: solutions exist

>>> Grape growers have always cultivated vineyards in challenging environments, adapting their practices to sometimes very difficult local conditions. Climate change, as a new player, is modifying the terroirs' characteristics rapidly and irremediably, giving viticulturalists major new challenges to face. <<<

The vine is an agricultural crop of major economic importance, in particular in Mediterranean countries. Like for any other crop, yields depend on soil fertility and climatic conditions. However, in viticulture, environmental conditions (soil, topography and climate[1]) are even more important because they not only determine yields, but also grape composition, as well as sensory attributes and quality of the wines made which impacts the price at which they can be sold.

Climate change: increasing temperatures…

High quality viticulture is only possible in a limited range of temperatures. Indeed, optimum wine quality is obtained when the ripening period of the grapes occurs in temperate conditions at the end of the growing season. When maturation happens too late in the season, grapes tend to be unripe at harvest time with low sugar to acid ratios, which results in green and acidic wines. When grapes reach maturity early in the season, when temperatures are still very high and days are long, the final product lacks freshness and aromatic complexity. Optimal conditions for the production of dry table wines are generally met when the grapes reach full ripeness between the 10th of September and the 15th of October on the Northern Hemisphere (10th of March-15th of April in the Southern Hemisphere): temperatures are still high enough to obtain an optimal maturity, but not too high to preserve a balanced sugar to acid ratio in the grape juice and freshness and a complex aromatic expression in the wine.

With increasing temperatures, grapes tend to ripen earlier in the season. Growers need to adapt to this situation by delaying phenology, in order to keep the harvest in the ideal window. The most efficient way is to choose later ripening varieties. This can be done, in a first step, by increasing the proportion of these varieties among local ones (e.g. more Cabernet-Sauvignon and less Merlot in the Bordeaux area, more Mourvèdre and less Syrah in the Languedoc area). Late ripening clones and more vigorous rootstocks are also an option. When even the latest ripening local varieties reach full ripeness too early, planting of late ripening non-autochthonous varieties can be an option.

Furthermore, training systems can be adapted by increasing trunk height, which will slightly reduce maximum temperatures in the fruit zone. In addition, maturity delaying canopy management practices include reducing leaf area to fruit weight ratio and limit leaf removal. Late pruning is



Bushvines in Aragon (Spain) a training system which is perfectly adapted to drought.

What about the soil?

Soil water holding capacity (SWHC) can, to a certain extent, compensate for climatic drought. This is why in dry climates vineyards should be established on soils with at least medium SWHC. This parameter is related to rooting depth. Deep soils have greater SWHC. Deep soil ripping before plantation also increases rooting depth.

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Riparia Gloire de Montpellier, Grézot 1	34EM, 420A, 5BB, 5C, 1616C, Rup Lot, 101-14Mgt, 8B, Schwartzmann, 1613C, 161-49C	3309C, SO4, Dog Ridge, 125AA, 41B, 216-3C, Fercal, Gravesac, Freedom, 333EM	Harmony, 196-17C, Georgikon28, Borner	99R, 44-53M, Ramsey, 1103P, 1447P, 110R, 140Ru

Carbonneau, 1985, Peccoux, 2011, Ollat et al., 2014, Serra et al., 2014

Widely used rootstocks from the less resistant (left) to the more resistant (right) to water stress

also an option to delay vine phenology[2]. All these adaptations to higher temperatures are environmentally friendly and have little or no impact on production costs.

...versus increased drought

The vine is a Mediterranean species which is highly resistant to drought. It can be cultivated with dry farming in extremely dry climates, down to 400 mm of rain per year, or even slightly less. Yield is negatively impacted, but not necessarily quality: many famous wines are produced worldwide in these conditions without irrigation, like Henschke Hill of Grace in Australia and Dominus Estate in Napa, California.

Although not every single growing place will be impacted in the same way, most of them will have to face more frequent and severe droughts during the growing season in the years to come. The use of resistant plant material (grapevine varieties and rootstocks) is an environmentally friendly and cost effective option to decrease vulnerability of vineyards to water deficits. Among widely used drought resistant rootstocks, 110 Richter has the advantage of possessing high quality performances. In extreme situations, 140 Ruggeri is even more resistant[3] to water stress. In general, these adapted rootstocks also promote grape yields. Similarly, important differences do exist among grapevine varieties[4]. Empirical knowledge exists among growers, who know that Grenache, Carignan and Cinsault are drought tolerant, while Tempranillo, Syrah, Merlot and Sauvignon blanc are not. Most Mediterranean varieties are less affected, because they have been selected by growers for this particular trait.

Adapted training systems already exist

Over centuries, wine growers of the Mediterranean basin have developed a training system which is perfectly adapted to drought: the so-called Mediterranean gobelet or bushvine. It makes it possible to cultivate vines in extremely dry conditions. Although gobelet trained vines generally produce low yields, they are easy to grow at low production costs.

Research progresses needed...

- Unravel the underlying physiological mechanisms of resistance to water deficit. This would help growers to optimize the use of drought resistant varieties in dry environments. The revival of local varieties adapted to these conditions can be an interesting challenge to detect some that may outperform Grenache and Carignan in their tolerance to drought.
- Find or generate rootstocks that may perform even better than 140 Ru or 110 Richter in dry conditions.
- Create a mechanical harvester for the gobelet training system to reduce labor costs.

It is a pity that these highly drought resistant vineyards are pulled out and replaced by trellised vines with increased water consumption, in a context where this resource is becoming increasingly scarce. One of the reasons is that there are currently no available mechanical solutions to pre-prune and harvest these vines. Another option is to reduce planting density in trellised vines[5]. When light interception by the canopy is limited through wider spacing, transpiration and water consumption are reduced.

Irrigation is an option, but raises questions about sustainability

To avoid yield losses due to drought, irrigation is also an option. However, it cannot be considered as a sustainable practice, because of increased competition for water resources, for instance with drinking water and use for food crops. Furthermore, in some cases (when winters are dry), it can lead to augmentation of vineyards' soil salinity, making them improper for cultivation in the long run. Lastly, only deficit irrigation should be conducted, with precise vine water status monitoring (e.g. by measuring stem water potential) in order to limit, as much as possible, the amount of resource used. However, even with fine-tuned management, the blue water footprint of an irrigated vineyard is generally at least 100 times higher compared to a dry farmed vineyard. ■

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1 van Leeuwen, C. and Seguin, G. (2006). The concept of terroir in viticulture. *Journal of Wine Research*, 17(1), 1–10. https://doi.org/10.1080/09571260600633135

2 van Leeuwen, C. and Destrac-Irvine, A. (2017). Modified grape composition under climate change conditions requires adaptations in the vineyard. *OENO One*, 51(2), 147–154. https://doi.org/10.20870/oeno-one.2017.51.2.1647

3 Ollat, N., Peccoux, A., Papura, D., Esmenjaud, D., Marguerit, E., Tandonnet, J.-P., Bordenave, L., Cookson, SJ., Barrieu, F., Rossdeutsch, L., Lecourt, J., Lauvergeat, V., Vivin, P., Bert, P.-F. and Delrot, S. (2015). Rootstocks as a component of adaptation to environment. In: H. Gerós, MM. Chaves, H. Medrano Gil, S. Delrot (eds) *Grapevine in a Changing Environment: A Molecular and Ecophysiological Perspective*. John Wiley & Sons, Hoboken, NJ, pp 68–108. https://doi.org/10.1002/9781118735985.ch4

4 Pou, A., Medrano, H., Tomàs, M., Martorell, S., Ribas-Carbó, M. and Flexas, J. (2012). Anisohydric behaviour in grapevines results in better performance under moderate water stress and recovery than isohydric behaviour. *Plant and Soil*, 359(1–2), 335–349. https://doi.org/10.1007/s11104-012-1206-7

5 van Leeuwen, C., Pieri, P., Gowdy, M., Ollat, N. and Roby, J.-P. (2019). Reduced density is an environmental friendly and cost effective solution to increase resilience to drought in vineyards in a context of climate change. *OENO One*, 53(2), 129–146. https://doi.org/10.20870/oeno-one.2019.53.2.2420