KEYNOTE LECTURE

Above and below–research challenges for the future of winegrape production

Cornelis van Leeuwen[1], Benjamin Bois[2], Agnès Destrac Irvine[1], Célien Durney[3,4], Gregory Gambetta[1], Mark Gowdy[1], Elisa Marguerit[1], Marc Plantevin[1], Laure de Rességuier[1], Clément Saint Cast[1], Zito Sébastien Zito[1], Nathalie Ollat[1]
*Corresponding author: vanleeuwen@agro-bordeaux.fr

[1] EGFV, Univ. Bordeaux, Bordeaux Sciences Agro, INRAE, ISVV, F-33882 Villenave d'Ornon, France
[2] Biogéosciences UMR 6282 CNRS UB, Université de Bourgogne, 6 Boulevard Gabriel, 21000 Dijon, France
[3] Agroécologie, INRAE, Institut Agro Dijon, Université Bourgogne Europe, 21000 Dijon, France
[4] Hennessy, Rue de la Richonne - CS20020, 16101 Cognac Cedex, France

INTRODUCTION

Grapevines interact with the climate (aboveground) and the soil (belowground), affecting the characteristics of winegrapes produced. These interactions are impacted by climate change, the erosion of biodiversity, and losses of soil organic matter (SOM). A valuable resource for adaptation to these impacts, however, may exist in the great genetic diversity in rootstocks, varieties, and clones. This presentation addresses the major abiotic impacts of these global changes on winegrape production and identifies avenues for future research.

IMPACTS

Climate change results in increased temperatures in winegrowing regions around the world. Wine quality may benefit from this trend in some regions when it leads to a more regular desired levels of grape ripeness. However, high temperatures can also result in elevated grape sugar levels, leading to the production of unbalanced wines with excessive alcohol levels. They can also reduce total acidity, leading to higher pH, which decreases perceived freshness and leads to less microbiological stability in wines. High temperatures also reduce anthocyanins in grape skins and modify perceived aromatic ripeness, resulting in modified wine typicity and possibly lower quality. In some specific situations, the advance of budbreak exposes the vines to increased spring frost risk.

The level of drought stress perceived by vines depends on rainfall, evapotranspiration and the duration from budbreak to harvest. Many winegrowing regions are increasingly exposed to drought, which if not excessive, can increase quality, particularly for red wines, but can also reduce yields. Vines can also be exposed to several stress factors simultaneously and the consequences of these "multi-stress" effects can be different compared to the sum of each stress considered separately.

Organic matter is decreasing in most cultivated soils because of erosion and/or an imbalance between mineralization of SOM and reincorporation of organic matter from crop residues, cover crops, or compost. Biodiversity, both above and belowground, is decreasing and may lead to increased disease impacts.

SOLUTIONS AND RESEARCH CHALLENGES

Adaptations to increased temperatures

Grape growers cannot change local temperatures, but by adopting varieties with delayed phenology (particularly for veraison) the ripening period is shifted to a cooler part of the season. Genetic variability in the timing of veraison across grapevine varieties and their clones is substantial and far from being fully exploited. Late ripening varieties, particularly from Mediterranean islands, should be more systematically studied, and phenology models should be parametrized for these varieties so the timing of their phenological stages under future climatic conditions can be predicted. Clonal diversity for this trait should also be more widely assessed and modelled. Models for sugar accumulation in grape berries should also be parametrized for a wider range of varieties in order to identify existing or new varieties with low sugar accumulation under high temperature conditions. Varieties adapted to warmer and dryer climates also need to have relatively low berry juice pH. The relative impact of organic acids and inorganic cations (particularly potassium) on grape and wine pH needs to be better understood.

Adaptations to increased drought

Genetic variability of water consumption and tolerance to drought in rootstocks, varieties, and clones is substantial, but the underlying root traits and physiological mechanisms are complex and not fully understood. The role of the soil in resilience to drought is also important, but not fully explored. Increasing water retention in soils and promoting deep rooting, either by appropriate pre-planting soil preparation or by selecting deep rooting genotypes, are efficient ways to limit excessive water deficits. The interaction of mycorrhizas with vine roots influencing water supply needs to be better understood and their contribution quantified. Because freshwater resources will be increasingly scarce, the water footprint of winegrape production should be maintained as low as possible. A widely accepted method for calculating the consumption of ground and surface water resources for winegrape production (i.e., blue water footprint) needs to be developed. To reduce this blue water footprint, dry farming should be maintained whenever possible, in particular using drought adapted plant material and training systems in dry areas. The advent of varietal wines has led to an increasing mismatch between the climatic requirements of grapevine varieties and the actual climate under which they are cultivated (e.g., the cultivation of varieties originating from cool and relatively wet climates like Merlot and Chardonnay in warm and dry regions). Consumer's acceptance for less well-known drought and heat tolerant varieties should be investigated. A possible alternative is to promote wines by their origin rather than by the variety, as this provides flexibility to growers to plant varieties best adapted to their local climatic conditions.

Decrease of soil organic matter and erosion of biodiversity

The use of cover crops is an effective way to limit soil erosion and restore SOM content. Only a limited number of plant species are currently used as cover crops, and research is needed to explore greater diversity for these crops to address particular challenges. For example, soil decompaction can be addressed by using plant species with deeper tap roots, and soil nitrogen supply can be improved by using nitrogen fixing species (legumes). Both such crops can also increase SOM. The impact of widely used natural cover-crops also needs to be better understood. And thanks to new molecular techniques, knowledge of soil microbiological diversity is rapidly increasing, but needs to be completed with functional approaches. High quality wines are most often produced in poor soils (from an agronomic perspective), in which the microbiological biomass can be presumed moderately low. This means that in terms of soil microbiology « more » is not always « better » and this dynamic may be more important than absolute quantity or diversity.

CONCLUSION

Global changes in climate, biodiversity, and organic matter in soil are creating major challenges for winegrape production. Improved understanding of vine and soil interactions will help develop promising new resources for adaptation, including improved use of the genetic diversity in plant material. Avenues for research can be designed to support growers in their quest to maintain yields and wine quality in a changing environment.