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Short-term adaptation of European viticulture to climate change: an overview from the H2020 Clim4Vitis action

>>> **Viticulture is exposed and vulnerable to extreme weather and climate change. In Europe, owing to the high socio-economic value of the winemaking sector, the development of adaptation strategies to mitigate climate change impacts will be of foremost relevance for its future sustainability and competitiveness. Some guidelines on feasible short-term adaptation strategies are provided here (Figure 1), collected by the Clim4Vitis action (https://clim4vitis.eu/). Long-term adapation startegies are described in an accompanying technical review.** <<<

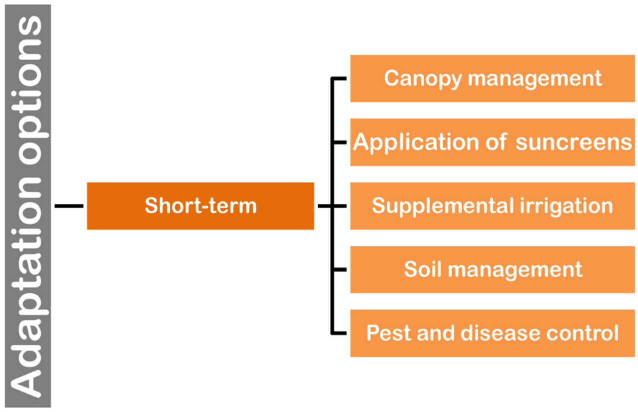

Figure 1. Summary of short-term adaptation options to mitigate climate change impacts on viticulture.

Short-term adaptation strategies are defined here as adjustments to typical viticulture practices that can be implemented within a growing season or from year to year. Some examples are outlined below, but the list is not exhaustive.

Adapted canopy management

The advancement of phenology stages is one of the most prominent climate change effects, shifting the ripening period to warmer conditions in the summer, and strongly affecting berry composition (e.g., acidity, anthocyanins, aroma compounds and sugar content) and wine typicity[1]. Appropriate canopy management can delay the development cycle of grapevine within a season to prevent final maturation stages occurring under above-optimum high temperatures or even heat stress. Leaf removal has already proven to be an efficient practice to delay the ripening process by limiting canopy photosynthesis and reducing the ratio of leaf area to fruit weight[2]. For instance, reducing the canopy area to less than 0.75 m^2/kg shortly after fruit set can increase the time from flowering to veraison by approximately 5 days[3]. Other measures, such as late winter pruning (around budbreak), can also delay the onset of budbreak as compared to the conventional mid-winter pruning, which can result in flowering or veraison delay by up to 5 days[3].

Application of sunscreen materials

The application of several sunscreen materials creates inert particle films upon leaves, such as calcium carbonate ($CaCO_3$), kaolin ($Al_2Si_2O_5(OH)_4$) and potassium silicate (K_2SiO_3), which can improve plant metabolic growth under heat, drought and radiative stresses[2]. For example, kaolin, a chemically inert white clay, with high reflectivity, has demonstrated its positive effects on leaf cooling and reducing leaf and cluster sunburns, resulting in improved fruit and wine quality under severe summer stress[4]. The use of kaolin can also enhance grape berry composition in terms of total phenols, flavonoids and anthocyanins, leading to improved antioxidant capacities in berries[4]. Other applications, such as the use of shade nets can also reduce sunlight exposure.

Supplemental irrigation

Grapevine is traditionally grown under rainfed conditions in many EU winemaking regions. However, in some regions (e.g., Mediterranean-type climates), the seasonal precipitation regime rarely fulfils crop water needs (~250 mm) for normal growth and development[3]. Supplemental irrigation can be essential to cope with frequent water deficits and maintain an expected yield level (economic interest), but additional financial costs and local regulatory issues (e.g., regarding the maintainance of wine typicity) can be important constraints[1]. Given the increasing scarcity of water resources, this supplemental irrigation should be implemented with water-saving in mind while trying to maximise the benefits. For instance, irrigation should be restrained in early growth stages (e.g., budbreak), but applied at the most sensitive stages, namely the inflorescence development and flower formation process[1]. To optimise such a strategy, appropriate irrigation systems should be installed. Expensive drip irrigation systems are widely recommended, as they improve water management by precisely determining the amount of water to be allocated to individual vines[5]. Direct plant water status indicators, such as stem/leaf water

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potential, trunk diameter or sap flow measurements, can be used to optimise the irrigation scheduling under drip irrigation systems[2]. A study conducted in Mediterranean climates showed the subsurface drip irrigation system using the threshold of leaf water potential at -0.4 MPa and -0.6 MPa before and after veraison respectively, was useful in improving grapevine water use efficiency and yield, without affecting grape quality[5]. A detailed assessment of overall benefits and costs (e.g., terrain factors, technological options and catchment-scale water savings) under future climate still needs to be carried out in order to implement an optimised irrigation strategy[2].

■ Soil management

Adequate soil management is an essential adaptation tool for improving the management of vineyard water supply and grapevine vigour, and for preventing soil erosion[2, 3]. Soil tillage can promote soil erosion, particularly in shallow soils on steep terrain, resulting in undesired nitrogen releases and hence adversely affecting grape yield and quality[2]. Therefore, limiting soil tillage is generally advised. Proper use of cover crop species can also provide good adaptive capacity. In the case of low water availability, cover crop species (e.g., self-reseeding annual legumes) with low competition for water and/or with positive contributions towards soil fertility should be selected[6]. In contrast, grass cover should be used in intense rainfall seasons to improve soil bearing capacity and limit vine vigour[3]. In future climates of higher temperatures and enhanced evapotranspiration, the application of organic or synthetic mulches (e.g., compost, bark or straw) will improve soil water retention capacity by reducing soil evaporation and limiting surface runoff[3].

■ Pest and disease control

Many wine regions may face an increasing risk of pests and diseases under higher temperatures and altered precipitation patterns[2]. Winegrowers are likely to be able to anticipate the changes in the population densities of already well-established insect pests in their vineyards, but the establishment of novel pests and diseases is also expected to increasingly occur under future climate scenarios[7]. Possible adaptation measures include vineyard irrigation that can help to limit leafhopper population outbreaks[7]. However, pest and disease control is a dynamic process that requires continuous monitoring and research investments to better understand the complex underlying mechanisms of each specific situation[7]. Comprehensive control measures (e.g., combined application of various natural compounds) can be transferred from regions where the risk is effectively controlled[2]. ■

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