Implications of potassium nutrition for grapes and wine

[1]Suzy Rogiers and [2]Rob Walker
[1]National Wine and Grape Industry Centre, Wagga Wagga, NSW
[2]CSIRO Agriculture and Food, Glen Osmond, SA

Winemakers are often concerned with the quantity of potassium (K) in the must. This is because high potassium reduces the free acids in the wine and raises wine pH. This results in a loss of tartness, reduced colour intensity in reds, and increased chance of oxidative spoilage. High potassium also lowers the tartrate to malate ratio and therefore increases the likelihood of malolactic fermentation, altering the organoleptic qualities of the wine. More tartrate in the crystal form might mean you have to add tartaric acid in the winery, resulting in additional costs. Cold stabilisation might also be necessary to remove the potassium bitartrate crystals prior to bottling. Therefore, the ability to modify berry potassium levels in the vineyard is valuable. However, considering the important role this nutrient has in overall vine functioning (Figure 49), it is critical that deficiency is avoided.

In the vine, potassium is important for:

- frost resistance (lowering the freezing point)
- drought resistance (maintain tissue turgor)
- photosynthesis (stomatal control)
- fruit set (pollen tube growth)
- defence against insect and fungal attack (strengthening cell walls)
- growth of tissues and berries (cell enlargement)
- berry sugar accumulation (vascular transport)
- ameliorating cell death (reactive oxygen species metabolism).

Potassium in soil and fertiliser application

Many Australian soils are naturally high in potassium and therefore potassium fertilisation is often not required. However, the availability of potassium can be limited in sandy soils, heavy clays and acid soils. Potassium is also lost from the vineyard through fruit removal, leaching or erosion. Potassium uptake can be reduced if other cations such as sodium, calcium and magnesium are abundant. A petiole analysis will help determine if potassium supplementation is required. Mulches and composts can provide an additional source of potassium to the vineyard, or if required it can be applied as potassium chloride (in low applications in low saline soils), potassium nitrate or potassium sulphate.

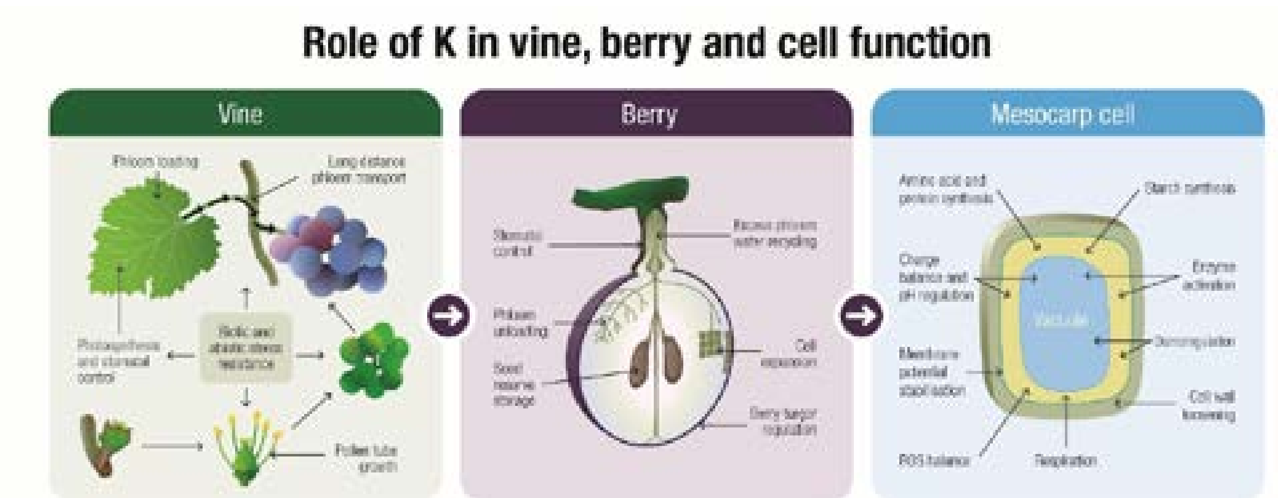

Figure 49. Functions of potassium (K) in the grapevine at the whole-plant, fruit and cellular level.

Cultural factors affecting potassium accumulation in the berry

Increasing input costs of winemaking, via including expensive tartaric acid additions, requires vineyard strategies that maximise wine acid levels, especially in warm climates. Managing berry potassium levels is a significant challenge for the warm viticulture regions of Australia.

The flesh and skin of the berry harbour most of the potassium and seeds also store a minor quantity. Berries accumulate some potassium prior to the onset of ripening but most of it is accumulated during the period of rapid sugar accumulation (Figure 50). Potassium can be sourced from the soil or relocated from the woody and vegetative structures. There are variety differences in uptake and partitioning of this nutrient and some rootstocks are also known to modify the potassium content in the scion.

Irrigation facilitates the uptake of many nutrients, including potassium. Water deficits may reduce the uptake of potassium but care must be taken as yield may be affected. Severe water stress should , however, be avoided at all times.

The effects of vine vigour, canopy shading, crop load and foliar potassium application on berry potassium accumulation are inconclusive and require further research. The compensatory mechanisms built into the vine may alter potassium mobilisation and partitioning so that reserves are drawn upon during times of low potassium uptake. Berry potassium levels may thus not respond readily to the cultural manipulation of nutrition, vine water uptake, bunch exposure or crop load.

Through a newly funded Wine Australia project, our group will examine how potassium levels in the soil and the vine affect berry and wine acidity. We intend to characterise the influence of cultural factors on uptake by the roots, partitioning to the various vine components, redistribution from perennial reserve stores, and finally accumulation by the berry. This project will build on a previous study funded through the ARC Training Centre for Innovative Wine Production, in collaboration with the University of Adelaide and CSIRO, where PhD student Zelmari Coetzee investigated the interaction of berry potassium with sugar and water accumulation.

Further reading

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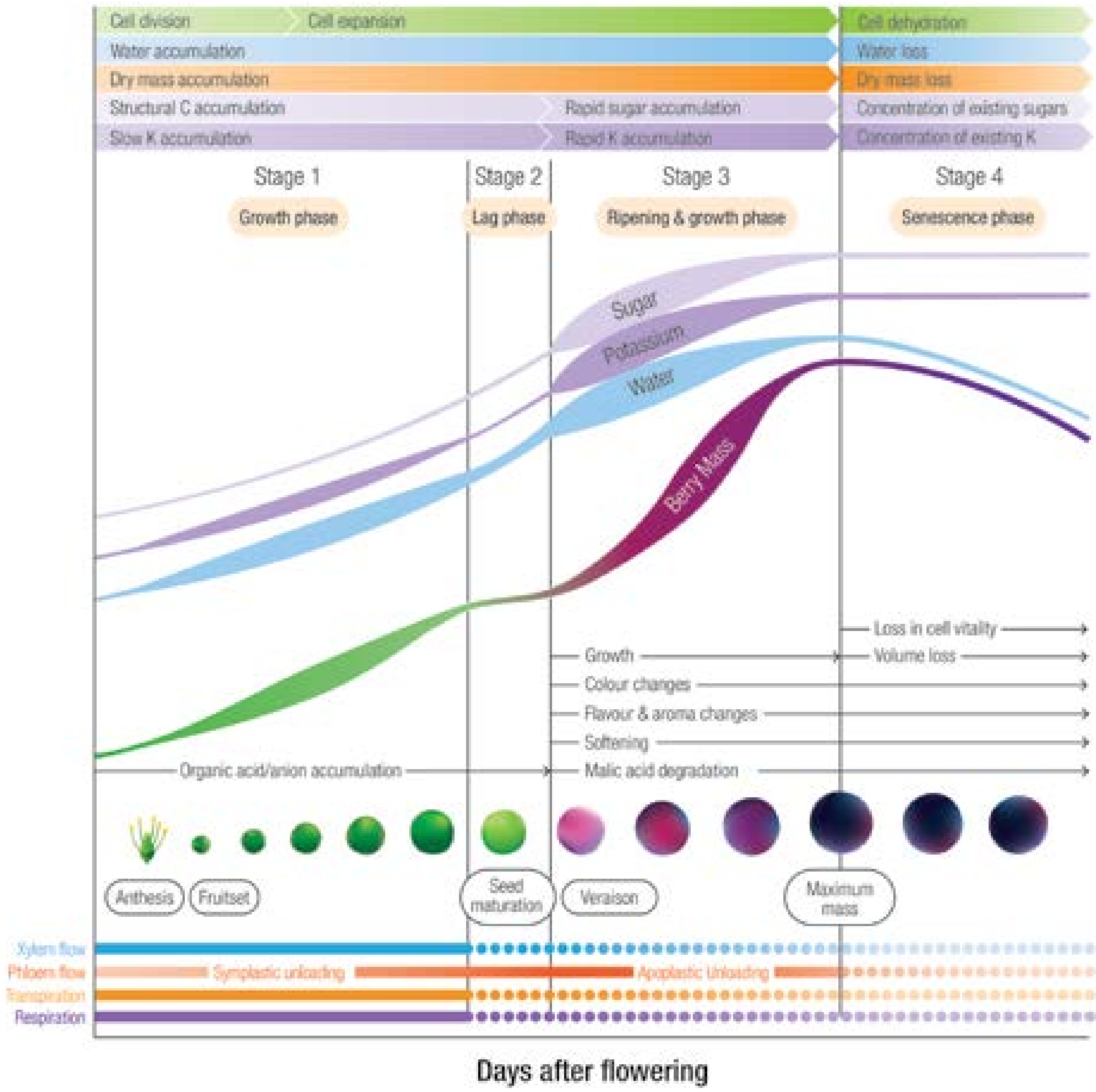

Figure 50. The four developmental stages of grape berries designating phases of rapid sugar, potassium and water accumulation. In Shiraz berries grown in a warm viticulture region of Australia, the lag phase occurs between 45 and 55 days after flowering, and maximum weight occurs at approximately 90 days after flowering. Stage 3 is associated with ripening and includes colour, flavour and aroma changes, softening and malic acid degradation. Relative changes in cell division, cell expansion, dry mass, structural carbon accumulation, xylem and phloem flow, transpiration and respiration are also indicated.