EGU21-11458
https://doi.org/10.5194/egusphere-egu21-11458
EGU General Assembly 2021

Grapevine nitrogen metabolism as a function of crop load using a ^{15}N-labelling approach

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This presentation addresses the actual concerns in viticulture regarding grapevine nitrogen (N) metabolism in the context of reducing both inputs and environmental pollution, while optimizing the balance between yield and wine quality. By adapting agronomical practices to the environmental conditions (i.e. soil and climate), it is possible to optimise both plant N use efficiency (NUE) and crop quality, while reducing N input in the vineyard. The present trial demonstrates the potential of crop-load limiting (via bunch thinning) to fine-tune plant NUE and optimise grape N composition at harvest. These results improve the comprehension of the seasonal plant N cycle in perennial crops and it contributes to the implementation of sustainable practices in vineyards and potentially in other crops.

Over the past decades, N supply in vineyards has been reduced with the aim of adjusting vigour and yield. Moreover, the development of cover cropping has led to increased competition for N resources in vineyards, which can, in some cases, be detrimental to both yield and quality of the crop. This evolution of management practices – without considering the environmental conditions – has led to situations with major grape N deficiencies, being detrimental to fermentation kinetics, yield and possibly wine quality. Given the major role of N in plant physiology, an integrative approach to managing grapevine N nutrition from soil to crop – in accordance with the environmental conditions – represents a sustainable solution for high-quality grape production.

In this trial on white cv. Chasselas (Vitis vinifera L.), plant N partitioning and grape composition were monitored over two years, in relation to both crop load and fertilisation. These aims were accomplished by testing a large crop load gradient (via bunch thinning, resulting in 0.7–5.2 kg per plant) and by using a ^{15}N-labelling method (fertilization with 10 atom % ^{15}N foliar urea). The results indicate that the mobilisation of root N reserves plays a major role in the balance of fruit N content. Carry-over effects to the next year were highlighted. N uptake and assimilation appeared to be strongly stimulated by high-yield conditions. Fertilisation largely contributed to fulfilling the high fruit N demand while limiting the mobilisation of root N reserves under high-yield conditions.

Plants were able to modulate both root N reserve mobilisation and N uptake as a function of crop load, thus maintaining a relatively uniform N concentration in fruits. However, the fruit free amino N profile was modified, which potentially affected aromas in grapes and wines. A modelling of the seasonal plant N cycle (i.e. uptake and efflux) is also proposed.

Key words: Nitrogen metabolism, ^{15}N-isotope labelling, crop load, grape composition, wine quality