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Carryover Effects of Yield Regulation on the Following Year's Grapes

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The integrated management of vine nitrogen nutrition guarantees suitable grape composition at harvest according to the production objective (yield and composition). An agronomic trial revealed the combined effects of fertilisation and yield regulation (via cluster thinning/green harvest) on carbon and nitrogen accumulation in the grapes. The presence of strong carryover effects suggests the necessity of pre-emptively controlling grape composition at harvest over at least two consecutive years, which implies rigorous long-term planning.


Yield regulation via cluster thinning (synonyms: green harvesting, cluster thinning, stripping) at the bunch closure stage (BBCH 75-77), Pully, Switzerland.

From must to wine: nitrogen footprint

Nitrogen is an essential element influencing vine development, yield and the vinification process, and hence wine quality. The yeast-assimilable nitrogen content of the must can easily be corrected in the cellar (e.g., by adding diammonium phosphate (DAP)), thereby guaranteeing the complete conversion of the sugars into alcohol thanks to proper fermentation kinetics. However, the concentration of aromatic precursors in the must remains low and the formation of aromatic metabolites during the vinification process is also affected by the deficiency status of the must, which negatively impacts the final organoleptic profile of the wine[1]. Ultimately, balanced vine nitrogen nutrition should be a prerequisite for producing grapes that are naturally balanced in amino acids, thereby offering the winemaker greater potential for producing wines of high quality.

Finding physiological balance

"Vine balance" is a term used to describe the balance between vegetative growth and fruit development. A balanced vine can both produce fully ripe grapes and set aside nutrient stores for the following year[2]. By contrast, an excessive crop load can alter grape ripening in terms of the accumulation of sugars[3]. In addition, for all other parameters remaining constant, an excessive leaf area can alter N accumulation in the grapes, particularly yeast-assimilable nitrogen concentration[4]. There are two ways to increase the leaf-to-fruit ratio: either by increasing canopy size or by limiting crop load. These two strategies have different implications for the total amount of nitrogen in the entire plant and for yeast-assimilable nitrogen concentration in the grapes[4,5] (Figure 1). A leaf-to-fruit ratio of the order of 1.0 to 1.2 m^2 of exposed leaves per kg of fruit is generally recommended for the Chasselas cultivar under Swiss climatic conditions[6,7].

Materials and Methods

The full protocol is described in the original article.

1. Experimental site and plant material

The study was conducted by Agroscope at Pully in Switzerland, in a temperate climate, over two consecutive winegrowing seasons (2017–2018). Climatic conditions were hotter and drier in 2018 than in 2017. Chasselas vines (white-grape variety *Vitis vinifera*, RAC4 clone) grafted onto 3309C were cultivated in 90-litre pots. Irrigation was kept to a minimum to avoid any water stress. The vines were single-Guyot pruned.

Leaves ⚖ Fruits	Concentration yeast assimilable nitrogen in the fruits	Quantity total nitrogen in the plant
↑ trimming height	↓	=
↓ fruit load	=	↓

FIGURE 1. Variations in grape nitrogen concentration and in total amount of nitrogen in the entire plant as a function of the leaf-to-fruit ratio. The leaf-to-fruit ratio can be increased either by increasing the leaf area or by reducing yield (adapted from Verdenal *et al.*, 2022[5]).

2. Experimental treatments

Two factors were studied:

➡Fertilisation at three levels: i) no fertilisation (CT), ii) fertilisation in 2017 only (F17), and iii) fertilisation in 2017 and 2018 (F17+18) via urea foliar spray around veraison at 20 kg N/ha/year (2.4 g N per vine; dilution, 3.44 % w/v).

➡Crop load: a load gradient was established by cluster thinning at the 'bunch closure' stage, creating low-yield and high-yield conditions.

3. Measurements and analyses

The vines were sampled on four occasions: at veraison and harvest in 2017 and 2018. Vine fertility, leaf area and yield were measured. The musts were analysed for carbon, total nitrogen, yeast-assimilable

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nitrogen, organic acids, pH, potassium and individual amino acids. The results were statistically analysed (ANOVA, PCA) to evaluate the effect of fertilisation, yield, and their interaction with the measured parameters.

Cluster thinning does not increase grape nitrogen concentration

Foliar urea fertilisation at the time of veraison increased the amount of nitrogen in the grapes at harvest in the same year but had no effect on grape ripeness (total soluble sugars (TSS), titratable acidity) and no carryover effect in the year n+1. Yield regulation, for its part, promoted grape ripening in the same year (+7 % TSS and –12 % titratable acidity) by reducing nitrogen and carbon requirements without influencing nitrogen concentration. Eliminating a portion of the fruit also promoted the storage of these same nutrients in the roots. Lastly, the interaction between yield regulation and fertilisation was negligible.

Carryover effects visible as from the 'veraison' stage of year n+1

The following year, differences were observed from the 'veraison' stage onwards: under low-yield conditions, TSS was higher (+25 %) and titrable acidity was lower (–18 %) (Figure 2). By contrast, the concentration of assimilable nitrogen remained constant in the fruits, regardless of plant crop load. Only the proportions of amino acids varied, enabling us to distinguish between the musts as a function of crop load from veraison onwards (Figure 3).

Conclusions

➨Cluster thinning strongly influences the N cycle of the vine in terms of assimilation, distribution in the grapes and storage in the roots.
➨Cluster thinning does not increase nitrogen concentration in the must. It does, however, promote grape ripening and nitrogen storage in the perennial parts of the vine.

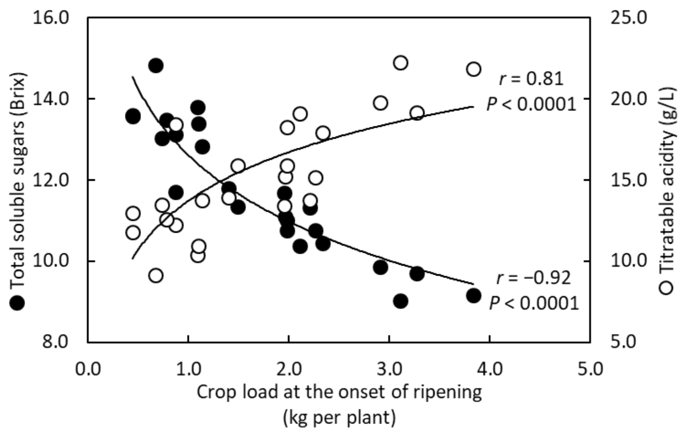

FIGURE 2. Variation in total soluble sugars (TSS) and titratable acidity in the must at the time of veraison (year n+1) as a function of crop load. Data at the 'veraison' stage in 2018, 'Chasselas' cultivar, Switzerland. Yield regulation was practised at the time of bunch closure in 2017 and 2018.

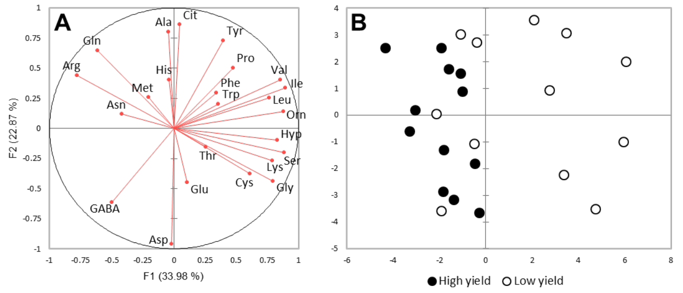

FIGURE 3. Distinguishing between amino acid profiles in the musts at the time of veraison (year n+1) as a function of crop load. Principal component analysis, 'Chasselas' cultivar, Switzerland. (A) Variables: Correlations between amino acid concentrations. (B) Observations: Shorter gaps between observations indicate similar amino acid profiles.

➨Cluster thinning alters the proportions of amino acids in the must for at least two years, which makes it a potential tool for modulating the organoleptic profile of the wine.
➨Vineyard nitrogen management must be considered from a multi-year perspective in order to optimise grape and wine quality while promoting integrated-farming practices. ■

Sources : *Sourced from the research article: "Carryover effects of crop thinning and foliar N fertilisation on grape amino N composition" (OENO One, 2022).*

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