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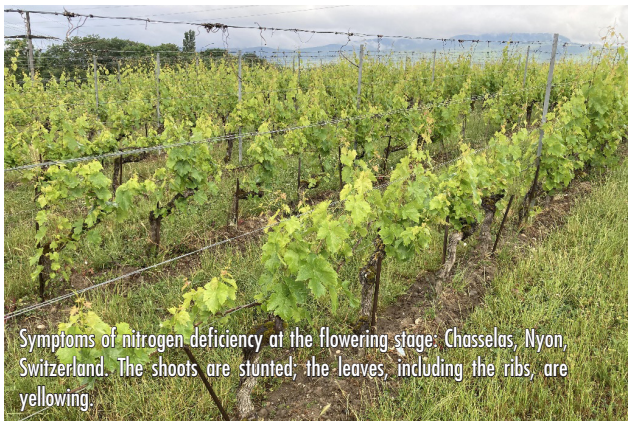
Sound nitrogen management in viticulture: from observation to must analysis

Thibaut Verdenal[✉1], **Ágnes Dienes-Nagy**[1], **Sandrine Belcher**[1], **Jean-Sébastien Reynard**[1], **Vivian Zufferey**[1]

Agroscope, 1009 Pully, Switzerland

Understanding and managing grapevine nitrogen nutrition is crucial for producing wines of quality. Visual observation is the first stage, supplemented by tools such as chlorophyl index assessment and leaf analysis. Total soil nitrogen is only of marginal relevance, as it is not directly assimilable. On the other hand, assimilable nitrogen in the must at harvest is a good indicator for adjusting fertilisation.



Symptoms of nitrogen deficiency at the flowering stage: Chasselas, Nyon, Switzerland. The shoots are stunted; the leaves, including the ribs, are yellowing.

Taking the time to observe the grapevine

Before fertilising, it is essential to assess the vine to determine its nitrogen status. Several complementary methods are available:

➡Visual observation: simple and free of charge; signs of nitrogen deficiency include lack of vigour, yellowish foliage and low fertility.

➡Plant analyses: more costly, these confirm deficiencies or excesses, but require expert interpretation according to grape variety and growth stage[1].

➡Chlorophyl index assessment: rapid and non-destructive, this approach uses tools such as SPAD 502 (Konica Minolta, Nieuwegein, Netherlands) or N-Tester (Yara, Oslo, Norway) to estimate nitrogen levels via leaf colour[2].

N.B.: Total (mineral and organic) nitrogen in the soil is not a good indicator of vine nitrogen nutrition. Organic matter must be mineralised before being assimilated by the vine. On the other hand, soil analysis enables monitoring of factors such as organic matter, C/N ratio, pH and lime, which influence nitrogen mineralisation. Organic matter improves soil structure and water supply.

Analysis of the must at harvest – the most accurate indicator

The yeast-assimilable nitrogen (YAN) present in the grapes at harvest is key in viticulture and oenology. It reflects grapevine nitrogen nutrition, influences alcoholic fermentation, and helps to shape wine aromas and flavours. Composed chiefly of ammonium and amino acids (except for proline and hydroxyproline), its concentration depends on environmental conditions and agricultural practices. Despite its importance, YAN at harvest is unfortunately not yet routinely analysed in the same way as sugars or acidity.

Yeast-assimilable nitrogen concentration in the must is often suboptimal for vinification, limiting yeast development and the speed of alcoholic fermentation, as well as aroma and flavour development. Below 200 mg N/l of assimilable nitrogen, the length of fermentation is negatively correlated with the concentration of assimilable nitrogen for a clarified must with an average sugar concentration. Below 140 mg N/l of assimilable nitrogen there is a sizeable risk of stalled alcoholic fermentation[3] (Table 1). This threshold is lower in the case of red-wine vinification, where grape nitrogen extraction is actually higher due to prolonged contact with the pomace. The Australian Wine Research Institute proposes a minimum threshold of 100 mg/l of assimilable nitrogen for red-wine production.

TABLE 1. Level of risk of stalled fermentation based on yeast-assimilable nitrogen concentration in the must at harvest for white-wine production (without skin maceration).

YAN in the must (mg/l)	Risk of stalled fermentation in clarified must
>200	None
140<…<200	Moderate
<140	High

The main nitrogen fertilisation methods

There are two possible nitrogen fertilisation methods in viticulture. These methods are complementary, although they have different objectives:

➡Soil fertilisation aims to maintain vine vigour and bud fertility with a view to achieving production quotas in the long term. Depending on the type of fertiliser used (organic or mineral), it is generally carried out in winter or spring, so that nitrogen is available at the time of peak vegetative growth of the vine.

➡Foliar fertilisation, for its part, has a short-term objective. Its aim is to stimulate the accumulation of nitrogen in the grapes to obtain a higher concentration of yeast-assimilable nitrogen in the must at harvest time of the same year. Carried out at veraison, at the beginning of grape ripening, it does not generally affect the following year's vine nutrition. In the event of confirmed nitrogen deficiency, foliar urea (10 to 20 kg N/ha), applied several times to encourage its assimilation, may prove highly effective, depending on the environmental conditions and grape variety[4].

To determine whether foliar fertilisation is essential, it would be particularly helpful to estimate from veraison onwards the concentration of assimilable nitrogen in the must during the upcoming grape harvest.

Must analysis at veraison – a way to predict harvest conditions

Early determination of must nitrogen content at veraison makes it possible to estimate must nitrogen content at harvest. This can be useful with a view to foliar fertilisation at the start of grape ripening, to correct assimilable nitrogen content in the must at harvest. At veraison grapes are already rich in nitrogen, which is mainly in the form of NH_4^+.

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Assimilable nitrogen concentration generally decreases during grape ripening due to the decrease in NH_4^+, whilst amino acid concentration remains relatively stable[5]. Agroscope produced an important database within the context of a ripening monitoring programme over a period of 24 years (1997-2020) in three reference vineyards in Switzerland (Nyon, Pully and Leytron): the Institute confirms the correlation between grape nitrogen concentrations at veraison and harvest for the Chasselas, Gamay and Pinot noir varieties (Figure 1). Environmental conditions (climate and soil) had a dominant impact; a strong effect was also noted for grape variety. Averaged over 24 years, Pinot noir and Gamay musts exhibited nitrogen concentrations that were generally comparable between veraison and harvest ($p = 0.142$ and 0.894, respectively); nitrogen concentration even increased for Pinot noir in the Pully vineyard ($p < 0.001$) (Table 2). The Chasselas musts, for their part, had lower concentrations of nitrogen at harvest more than nine times out of ten; a severe assimilable nitrogen deficiency (<140 mg N/l) was detected from veraison onwards in 13 cases, mainly in the Nyon vineyard, and was confirmed at harvest in over 90 % of cases. Bearing in mind the grape variety, early determination of nitrogen concentration in the must of grapes sampled at veraison is thus a good indicator of the future concentration at harvest.

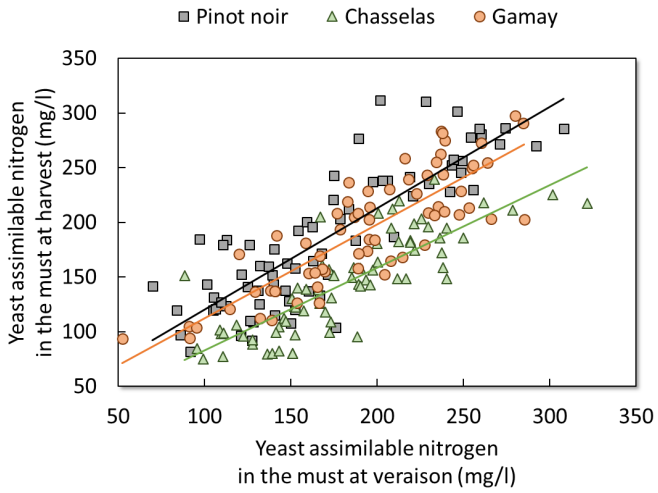

FIGURE 1. Correlation between the assimilable nitrogen concentrations of three grape varieties sampled at veraison and harvest (1997-2020). Chasselas ($n = 72$; $r = 0.82$; $p < 0.0001$), Gamay ($n = 66$; $r = 0.84$; $p < 0.0001$) and Pinot noir ($n = 72$; $r = 0.84$; $p < 0.0001$).

TABLE 2. Assimilable nitrogen content of Chasselas, Pinot and Gamay musts at veraison and harvest. Averages over 24 years (1997-2020). ***p-value < 0.001; ns = not significant.

Vineyard	Grape Variety	YAN (mg/l)		Variation between the two dates	p-value
		Veraison	Harvest		
Nyon	Chasselas	149	107	-28 %	***
	Pinot noir	146	151	4 %	ns
	Gamay	168	159	-5 %	ns
Pully	Chasselas	189	161	-15 %	***
	Pinot noir	163	190	17 %	***
	Gamay	177	186	5 %	ns
Leytron	Chasselas	207	165	-20 %	***
	Pinot noir	204	215	5 %	ns
	Gamay	239	235	-2 %	ns
Average of three vineyards	Chasselas	181	144	-20 %	***
	Pinot noir	171	186	9 %	ns
	Gamay	195	194	-1 %	ns

Towards sustainable management of grapevine nitrogen nutrition

Each of the observations and measures described above has its advantages and drawbacks. Taken together, they complement one another and allow for a better understanding of grapevine nitrogen dynamics. That said, once a nitrogen deficiency has been confirmed, fertilisation is not necessarily appropriate. Grapevine nitrogen nutrition status is heavily influenced by the environmental conditions of the plot in question, but also by the choice of growing techniques[6]. Before even considering the application of fertiliser, therefore, consistency in the following technical choices should be ensured:

- Plant material (variety and rootstock)
- Soil maintenance
- Leaf/fruit balance
- Water supply.

Grapevine nitrogen nutrition is worked out over the long term. Carry-over from the previous year and anticipation of the following year must be taken into account. By way of example, depending on environmental conditions, planting a grass cover may engender intense water/nitrogen competition for the grapevine. Nitrogen deficiency can thus arise in two to five years, with repercussions for yield and wine quality. Re-establishing balanced nutrition, for its part, can take several years. ■

Sources : *Sourced from the research article: "Nutrition azotée de la vigne: mesures et interprétations" (Recherche Agronomique Suisse, 2023). https://doi.org/10.34776/afs14-167*

1 Spring, J. L., & Verdenal, T. (2017). Fertilisation en viticulture : Principes de fertilisation des cultures agricoles en Suisse (PRIF). *Recherche Agronomique Suisse*, 8, chapter 12. https://www.agrarforschungschweiz.ch/fr/2017/06/12-fertilisation-en-viticulture-prif-2017/

2 Verdenal, T., Zufferey, V., Reynard, J. S., & Spring, J. L. (2023). Nitrogen nutrition status of the vine: correlation between N-tester and SPAD chlorophyll indices. *IVES Technical Reviews*. https://doi.org/10.20870/IVES-TR.2023.7649

3 Bell, S.-J., & Henschke, P. A. (2005). Implications of nitrogen nutrition for grapes, fermentation and wine. *Australian Journal of Grape and Wine Research*, 11, 242-295. https://doi.org/10.1111/j.1755-0238.2005.tb00028.x

4 Verdenal, T., Dienes-Nagy, Á., Belcher S., Reynard J.-S., & Zufferey V. (2025). Fertilisation foliaire en viticulture: comparaison de deux engrais minéraux. *Recherche Agronomique Suisse*, 16, 90-95. https://doi.org/10.34776/afs16-90

5 Nisbet, M. A., Martinson, T. E., & Mansfield, A. K. (2014). Accumulation and Prediction of Yeast Assimilable Nitrogen in New York Winegrape Cultivars. *American Journal of Enology and Viticulture*, 65, 325-332. https://doi.org/10.5344/ajev.2014.13130

6 Verdenal, T., Dienes-Nagy, Á., Spangenberg, J. E., Zufferey, V., Spring, J.-L., Viret, O., Marin-Carbonne, J., & van Leeuwen, C. (2021). Understanding and managing nitrogen nutrition in grapevine: a review. *OENO One*, 55, 1-43. https://doi.org/10.20870/oeno-one.2021.55.1.3866