



Must composition and nitrogen uptake in a long-term trial as affected by timing of nitrogen fertilization in a cool-climate Riesling vineyard

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In: American Journal of Enology and Viticulture. 59(3):255-264. 2008

- The timing of N fertilization needs to consider the seasonal fluctuations in nitrogen (N) uptake. These could be summarized as follows:
 - _ *during the four weeks after budbreak*: N is sourced from N stored in permanent structures,
 - _ *from 2 weeks before bloom to 4 weeks after bloom*: there is a major N uptake by the roots, and
 - _ *after 4 weeks post-bloom*: new peaks of N uptake happen at veraison and from harvest to leaf fall.
- In Germany, the recommended amount of N fertilizer ranges from **30-75 kg/ha yearly**, but there are few recommendations regarding the best timing. One of the reasons is that vines take 4 to 5 years to respond to even highly different fertilizer amounts, so research on timing often ends prematurely. This is probably why there is such inconsistency in the literature regarding the effect of N on parameters such as yield, Brix, or must composition.
- In this 15-year trial conducted in a Riesling vineyard in Rheingau, Germany, the authors compared the following N fertilization treatments: **0/0, 0/30, 30/0, 0/60, 30/30, 60/0, 90/0, 60/30 and 30/60**, the first number indicating the fertilization rate at **budbreak** (in kg of N/ha of ammonium nitrate), and the second number indicating the fertilization rate at **fruitset**. (There was no 90 kg N/ha at fruitset treatment (0/90) because this is not a recommended fertilization practice for a cold climate.) The vineyard soil was a deep loamy sand with high available water capacity. Each treatment had 4 completely randomized replications, with 48 vines per replication. For each fertilization treatment, the authors measured *soil characteristics, growth characteristics, yield, and juice composition*.
- **Effect on soil.** 1) Neither the timing nor the amount of nitrogen fertilization affected soil organic matter, soil pH, or soil chemical parameters other than nitrogen. 2) Soil N was clearly affected by N fertilization timing: fertilization at budbreak resulted in the highest soil nitrogen at fruitset, whereas fertilization at fruitset increased soil N mainly at veraison. 3) Overall, fertilization at budbreak resulted in higher soil N than fertilization at fruitset.
- **Effect on vine growth.** 1) Pruning weights were reduced 20% in the unfertilized control compared to the fertilized treatments. Similarly, leaf size was reduced 18%, and leaf chlorophyll 10%, in the unfertilized control. 2) The *amount* of N fertilization was highly correlated with leaf N concentration. 3) Besides N, only Mg and Ca also increased with increased N fertilization, whereas P, K, and Cu decreased with increased N fertilization. (See original text for some exceptions). 4) The *timing* of N fertilization only showed an effect on vine growth at the highest rate (90 kg N/ha), in which case budbreak application showed higher leaf N concentration than fruitset application.

• **Effect on yield.** 1) The unfertilized control yielded 16% less fruit than the fertilized treatments. But treatments fertilized with 90 kg N/ha also showed lower yield than treatments fertilized with 30 and 60 Kg N/ha. 2) Regarding *timing*, N fertilization at budbreak resulted in 3% to 5% lower yield than fertilization at fruitset.

• **Effect on juice composition.** 1) In general, Brix and TA decreased with higher N fertilization, whereas pH increased. But it's important to note that timing was able to reverse some of these effects at moderate-to-high N amounts. For instance, Brix was decreased by fertilization at budbreak compared with fertilization at fruitset. (Once again, see original text for details). 2) N was the only element in the juice that showed an increase due to N fertilization. Unfertilized vines resulted in significantly lower juice N. As for timing, juice N concentration was lower in the treatment fertilized at budbreak, compared to that fertilized at fruitset (this effect was observed at the 30 or 90 kg N/ha level, but not the 60 kg N/ha). 3) Fertilization changed the amino acid profile of the juice. For instance, it increased arginine and glutamine (which comprise 60% of all juice amino acids), whereas it decreased or had no effect on other amino acids (proline, leucine, tryptophan).

• Fertilization effects on vineyard growth and wine quality are very complex. In their discussion (highly recommended) the authors emphasize:

- the large variability due to year: *vintage* effects were often more important than fertilization *amount* or *timing* effects;
- the large variability reported in the literature regarding:
 - whether earlier fertilization results in higher leaf N or in lower leaf N;
 - whether high fertilization amounts decrease or increase yield;
 - whether N fertilization increases or decreases Brix.

The literature does seem to agree on a few points:

- N-fertilized vines always tend to have higher amino acid levels: Thus, **amino acid concentration seems to be a good indicator of vine N status**;
- **unfertilized vines tend to have low amounts of yeast-assimilable N** (<150 mg N per liter).
As a reference, recommended nitrogen levels for low risk fermentations are 70-270 mg N per liter.

In summary, fertilizing with *amounts* of 30 to 60 kg/ha is a recommended practice in this cool-climate study due to its beneficial influence on Riesling wine quality. As for *when* to fertilize, even in this study there seemed to be no perfect answer. Earlier fertilization (budbreak) tends to make the period of peak N supply and peak N uptake coincide, and resulted in increased N concentrations in leaves and other vegetative organs. On the other hand, later fertilization (fruitset) tends to benefit grape maturity and must composition (higher juice N), but resulted in a slightly elevated risk of N leaching and groundwater pollution.

Author: Bibiana Guerra, Editors: Kay Bogart, Matthew Fidelibus. This summary series funded by J. Lohr Vineyards & Wines.