 Australian Journal of Grape and Wine Research 11, 242–295, 2005

Implications of nitrogen nutrition for grapes, fermentation and wine

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Abstract

This review discusses the impacts of nitrogen addition in the vineyard and winery, and establishes the effects that nitrogen has on grape berry and wine composition and the sensory attributes of wine. Nitrogen is the most abundant soil-derived macronutrient in a grapevine, and plays a major role in many of the biological functions and processes of both grapevine and fermentative microorganisms. Manipulation of grapevine nitrogen nutrition has the potential to influence quality components in the grape and, ultimately, the wine. In addition, fermentation kinetics and formation of flavour-active metabolites are also affected by the nitrogen status of the must, which can be further manipulated by addition of nitrogen in the winery. The only consistent effect of nitrogen application in the vineyard on grape berry quality components is an increase in the concentration of the major nitrogenous compounds, such as total nitrogen, total amino acids, arginine, proline and ammonium, and consequently yeast-assimilable nitrogen (YAN). Both the form and amount of YAN have significant implications for wine quality. Low must YAN leads to low yeast populations and poor fermentation vigour, increased risk of sluggish/stuck/slow fermentations, increased production of undesirable thiols (e.g. hydrogen sulfide) and higher alcohols, and low production of esters and long chain volatile fatty acids. High must YAN leads to increased biomass and higher maximum heat output due to greater fermentation vigour, and increased formation of ethyl acetate, acetic acid and volatile acidity. Increased concentrations of haze-causing proteins, urea and ethyl carbamate and biogenic amines are also associated with high YAN musts. The risk of microbial instability, potential taint from *Botrytis*-infected fruit and possibly atypical ageing character is also increased. Intermediate must YAN favours the best balance between desirable and undesirable chemical and sensory wine attributes. 'Macro tuning', of berry nitrogen status can be achieved in the vineyard, given genetic constraints, but the final 'micro tuning' can be more readily achieved in the winery by the use of nitrogen supplements, such as diammonium phosphate (DAP) and the choice of fermentation conditions. This point highlights the need to monitor nitrogen not only in the vineyard but also in the must immediately before fermentation, so that appropriate additions can be made when required. Overall, optimisation of vineyard and fermentation nitrogen can contribute to quality factors in wine and hence affect its value. However, a better understanding of the effect of nitrogen on grape secondary metabolites and different types of nitrogen sources on yeast flavour metabolism and wine sensory properties is still required.

Keywords: *nitrogen, fertilisation, grape, must, wine,* Vitis vinifera, *yeast,* Saccharomyces cerevisiae, *fermentation, flavour*

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COOPERATIVE RESEARCH CENTRE FOR VITICULTURE

Nutrient uptake of grapevines in relation soil type and irrigation method

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Objectives:

- Determine the extent of water and nutrient loss from drainage and surface run-off in irrigated vineyards.

- Define vine nutrient uptake requirements in relation to vineyard environment and productivity.

- Develop management strategies to improve nutrient use efficiency, and minimise losses from the vineyard.

Project details:

- Project is a collaboration between CSIRO Land and Water, NWGIC, DPI Victoria, McWilliams Wines, and industry partners.

- Six trial sites have been established in irrigated vineyards in the Riverina (Figure 1). Additional trial sites in Victoria, South Australia and Western Australia.

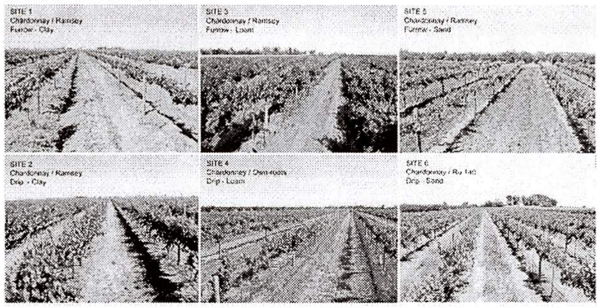

Figure 1. Photographs of the six Riverina trial sites taken in Spring 2003. Fertilizer application rates and estimates of vine nitrogen requirements are shown in Table 1.

- Installation of soil instrumentation (and flumes at selected sites) will be completed this winter, allowing full monitoring to commence in spring 2004.

- During the first year of the project (2003/2004) destructive sampling was undertaken at key growth stages to characterise vine nutrient use at each site. Selected data from these samplings are presented in the following section.

Results:

Table 1. Comparison of nitrogen fertilizer application rates (over whole season) with vine nitrogen usage up to harvest 2004. Fruit and canopy nitrogen content was estimated from 8 shoots at harvest, but then adjusted for the yields from handpicked replicate viine panels. The calculation does not include growth of permanent structure. N_{diff} is the difference between applied fertilizer and fruit nitrogen content.

Site	Year planted	Petiole (bloom)	N Fertilizer applied	Canopy total N (harvest)	Fruit total N (harvest)	N_{diff} (applied N - fruit N)
		%N	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}	kg ha^{-1}
1	2002	1.19	80.0	17.2	15.1	64.9
2	1994	1.08	14.0	61.9	42.0	-28.0
3	2000	1.50	27.0	61.1	46.5	-19.5
4	2002	1.58	73.0	29.1	27.7	45.3
5	2002	1.32	80.0	17.8	30.5	49.5
6	2001	0.90	33.1	27.0	20.1	13.0

Preliminary observations:

- For Chardonnay vineyards in their first cropping season (planted 2002), N fertilizer rates were double that of the more established vineyards.

- In the four younger vineyards, applied N considerably exceeded the amount of N removed from the vineyard with the fruit at harvest.

- The youngest vines also carried a heavy crop load in relation to leaf area, and competition with fruit during ripening may have reduced the capacity for excess N fertilizer to be used for vegetative growth.

- Although a very simplified comparison, these findings suggest that significant nutrient losses from the vineyard may occur during irrigation. Monitoring of water and nutrient movement on different soil types will address this question in the coming season.

Acknowledgements: The authors greatly appreciate the assistance provided by Rob Lamont and Stewart Field for field work associated with the study. We also acknowledge the ongoing work of project collaborators, including Dr Paul Hutchinson and David Deery (CSIRO Land & Water, Griffith).

2012 SPENKER ZIN									
Date	Event/Temperature	Hydro-sp grav.	Hydro-Brix	Refract-Brix	Refract-pot. alc.	Free sulfite/ Malic acid ppm	pH-meter	TA-pH meter	Details - Additions & notes
22/X	AM, ARRIVE	1.104	24.6				4.02		MbS, Lysozyme, 300gTA
22/X	pm						3.64		100gTA
23/X	am					YAN 353!	3.67		20mLColorpro, 1g Lallzyme, 60g FT Rouge, 100gTA
23/x	pm						3.45		
24	12								
25	12								
26	14.9			50g D21					30g OptiRed
28	22	1.076							40g FK
29	32!	1.002!							

Date	Event/Temperature	Hydro-sp grav.	Hydro-Brix	Refract-Brix	Refract-pot. alc.	Free sulfite/ Malic acid ppm	pH-meter	TA-pH meter	Details - Additions & notes
30/X	25.8	1.00							ML + 26g Optimallo Plus
31/X									10g DAP + leftover must
1/XI	20	1.004							
2/XI	21.3	1.002							
4/XI		1.002							
6/XI	PRESS	0.99 (clear juice)					3.62		
9/XI	TRANSFER TO 200L								
22/XI	TRANSFER TO BARREL + 20L GLASS								
1/XII						Malic = 30ppm			20%MbS = 35mLs (barrel) + equiv to glass
6/I						Sulfite 20.8 ppm	3.68		50g TA, 20mL 20% MbS

Date	Event/Temperature	Hydro- sp grav.	Hydro- Brix	Refract- Brix	Refract- pot. alc.	Free sulfite/ Malic acid ppm	pH- meter	TA- pH meter	Details - Additions & notes
11/XI	TRANSFER TO 200L					43.2	3.62		TA - 50g, 20Ml 20% MBS