ASSESSING RESERVE NITROGEN AT DORMANCY FOR PREDICTING SPRING NITROGEN STATUS IN CHARDONNAY GRAPEVINES

Authors:Bruno HOLZAPFEL[1,2*] and Jason SMITH[1]

[1]*National Wine and Grape Industry Centre, Wagga Wagga, New South Wales 2678, Australia*
[2]*New South Wales Department of Primary Industries, Wagga Wagga, New South Wales 2678, Australia*

*Corresponding author: *bruno.holzapfel@dpi.nsw.gov.au*

Abstract:

Context and purpose of the study - Nitrogen (N) supply strongly influences vine productivity and berry composition, matching availability and uptake requirements of vines during the growing season is essential to optimize vine nutrition. The nutritional status of grapevines is commonly assessed by the determination of petiole nutrient concentrations at flowering. The reserve N could also be an earlier indicator for grapevine N status, this work aimed to assess how the petiole levels relate to these perennial N reserves.

Material and methods - Five Chardonnay vineyards were planted two years prior and one Riverina vineyard 10 years prior to study commencement. The N levels in various perennial tissues and in the petioles at flowering were determined in these vineyards; vine productivity and berry ripeness were also assessed.

Results - The application of N fertiliser generally increased petiole N levels at bloom, the winter N reserves in root and spur tissues had a strong relationship with spring N status. A spur N concentration between 0.3 to 0.4 % and root N concentrations of 1.0 % relating to the lower value of the adequate range in the petiole at flowering (0.8 %). The determination of root and spur N during dormancy could assist in assessing N status, allowing for adjustment of N supply earlier in the season, prior to petiole levels at flowering are determined. However, it would be expected that the uptake between burst and flowering will alter petiole levels, which would be influenced by N fertiliser applications and by soil processes that are influenced by soil temperature and moisture.

Keywords: Nutrient status, nitrogen, requirements, reserves

1. Introduction.

ASSESSING RESERVE NITROGEN AT DORMANCY FOR PREDICTING SPRING NITROGEN STATUS IN CHARDONNAY GRAPEVINES

Bruno Holzapfel[1,2] **and Jason Smith**[1,3]

[1]National Wine and Grape Industry Centre, Wagga Wagga, NSW 2678, Australia.
[2]New South Wales Department of Primary Industries, Wagga Wagga, NSW 2650, Australia.
[3]New South Wales Department of Primary Industries, Orange, NSW 2800, Australia.

Introduction

Nitrogen (N) supply strongly influences vine productivity and berry composition. Matching availability and uptake requirements of vines during the growing season is essential to optimize vine nutrition. The nutritional status of grapevines is commonly assessed by the determination of petiole nutrient concentrations at flowering. During the season, the uptake, storage and mobilisation of N within grapevines vary with the stage of phenological development of vines (Wermeliger 1991). N status at the beginning of the season is influenced by the N uptake and vine productivity of the previous season, with early growth and development strongly dependant on N mobilised from reserves (Conradie 1992, Zapata et al. 2004). These reserves are predominantly accumulated N in wood and roots from uptake between harvest and leaf fall in the warmer wine growing regions (Conradie 1980, Schreiner et al. 2006). The stored N is important because early demand in spring cannot be matched by root uptake (Cheng et al. 2004, Glad et al. 1994). This work aimed to assess how the petiole N levels relate to these perennial N reserves, and if reserve N could be used as an early indicator of vine N status.

Materials and Methods

Experimental sites and locations

Six commercial Chardonnay vineyards were used in this investigation. These were located in the Riverina grape growing region in New South Wales (Australia), which is classified as a very hot grape growing region with a mean January temperature (MJT) of 23.9 °C and mean annual rainfall of 406 mm. Five vineyards were planted two years prior to the start of the study, and one vineyard planted 10 years prior (Figure 1). Three vineyards were furrow irrigated (F) and the other three were drip irrigated (D). For both the drip and furrow irrigated systems three soil types were selected: sandy loam (S), loam (L) and clay loam (CL). All of the vineyards were trained to a single-wire cordon, with the exception of DS which had a double cordon and were mechanically harvested. However, planting density, rootstock, and clone varied among vineyards.

Figure 1: Six Chardonnay vineyards in the Riverina grape growing region, top row drip and bottom row furrow irrigated vineyards different soil types from left to right: sandy loam (S), loam (L) and clay loam (CL).

Sample collection and analysis

In each vineyard, four replicated panels of eight vines were used for petiole and shoot sampling at flowering, and also for wood and root sampling to determine nitrogen (N) reserve concentrations in these tissues at dormancy. Roots and spurs (one-year-old wood) were collected from each plot at pruning (or just prior to), the root samples ranging in diameter from 2 to 5 mm. The bulked spurs or roots from each replicate of eight vines were then manually cut into small pieces, mixed, and oven dried. Shoot samples were collected at flowering, one random shoot from each of the eight vines in each plot. The shoot was cut hard against the spur to include all of the current season's growth. The tissues were washed in phosphate free detergent, tap water and then de-ionised water. At flowering 25 petioles from opposite bunches were collected from the eight vines of a replicate as per the shoot sampling.

Shoot tissue, petioles, spurs and roots were oven dried at 70 °C. The tissue was coarse ground to 5 mm with a heavy duty cutting mill (Restch SM2000, Haan, Germany), and then to 0.12 mm with an ultra-centrifugal mill (Restch ZM100). Petioles were ground only with the latter. Total N content of all collected plant tissue was determined with a model series 2 total combustion gas chromatograph using a 15 mg sub-sample (Carlo Erba NA 1500, Italy).

Acknowledgements

The work was supported by the National Wine and Grape Industry Centre, and the Australian grapegrowers and winemakers through their investment body, Wine Australia, with matching funds from the Australian government.

Wine Australia for Australian Wine

Results and discussion

Petiole and shoot N

The N status indicated by the petiole concentrations at flowering was influenced by the N application. However, this was less pronounced in the N shoot concentrations at this phenological stage (Figure 2).

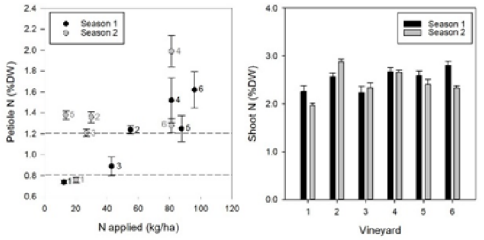

Figure 2: Relationship between petiole N concentrations at flowering and N applied in the preceding post-harvest and pre-bloom periods (left), broken lines indicate optimal N concentrations. Shoot N concentration at flowering in six Chardonnay vineyards and two seasons (1 = DS, 2 = DL, 3 = DCL, 4 = FS, 5 = FL, 6 = FCL). Error bars represent SE (n=4) within each season.

Winter N reserves and status

The N reserve tissues (roots and spurs) are related to the N status at flowering, this indicates the dependence on N reserves for the initial annual growth (Figure 3).

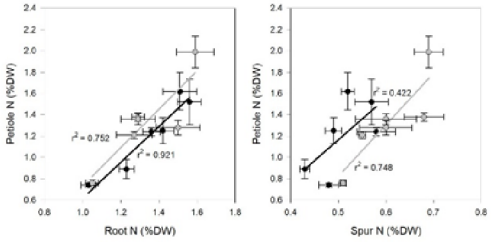

Figure 3: Relationships between petiole N concentrations at flowering with root (left) and spur N (right) concentration at dormancy in six Chardonnay vineyard (1 = DS, 2 = DL, 3 = DCL, 4 = FS, 5 = FL, 6 = FCL). Bi-directional error bars represent SE (n=4) within each season.

Conclusions

The application of N fertiliser generally increased petiole N levels at bloom, the winter N reserves in root and spur tissues had a strong relationship with spring N status. A spur N concentration between 0.3 to 0.4 % and root N concentrations of 1.0 % relating to the lower value of the adequate range in the petiole at flowering (0.8 %). The determination of root and spur N during dormancy could assist in assessing N status, allowing for adjustment of N supply earlier in the season, prior to petiole levels at flowering are determined. However, it would be expected that the uptake between burst and flowering will alter petiole levels, which would be influenced by N fertiliser applications and by soil processes that are influenced by soil temperature and moisture.

References

Cheng, L., G. Xia, and D.J. Bates (2004) J. Amer. Soc. Hort. Sci. 129, 660-666.
Conradie, W.J. (1980) S. Afr. J. Enol. Vitic. 1, 59-65.
Conradie, W.J. (1992) S. Afr. J. Enol. Vitic. 13, 45-51.
Glad, C., J. Farineau, J.-L. Regnard, and J.-F. Morot-Gaudry (1994) Am. J. Enol. Vitic. 45, 327-332.
Schreiner, R.P., C.F. Scagel, and J. Baham (2006) HortScience 41, 336-345.
Wermeliger, B. (1991) Int. Symp. Nitrogen in Grapes and Wine, 51-59.
Zapata, C., E. Deléens, S. Chaillou, and C. Magné (2004) J. Plant Physiol. 161, 1031-1040.