# viti-notes
[grapevine nutrition]

Research to Practice

## Petiole analysis

**Viti-note Summary:**

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**Other topics in this Viti-Notes series include:**

- Nitrogen fertilisation
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### Plant tissue analysis

Plant tissue analysis provides an estimate of vine nutrient status which can reflect uptake from the soil. This makes plant tissue analysis a useful tool to quantify the nutrient status of vines, verify any suspected deficiencies/toxicities in the vines and for problem diagnosis.

Like humans, grapevines are in a state of 'nutrient flux', that is the nutrient status of the vine is dependent on the time of the day (e.g. morning versus afternoon) and the stage of growth (e.g. dormant versus flowering or ripening). It is important to remember that plant tissue analysis represents a snap shot of nutrient concentration in the sampled tissue at that particular time.

### Sample collection

The standard tissues used for grapevine tissue analysis are the petioles or leaf stalks. Petiole samples are collected from opposite bunches at 80% flowering (Figure 1). Leaf blade samples can be collected at veraison for late season analysis.

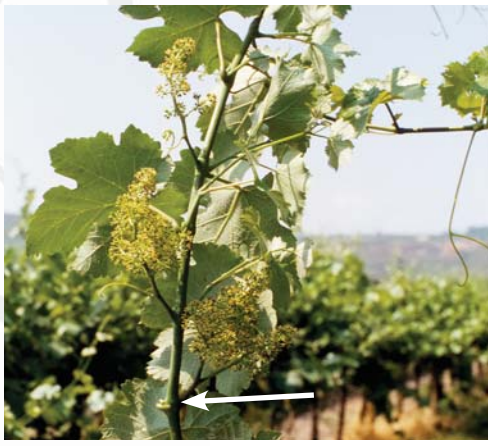

*Figure 1. Petiole and leaf blade samples should be taken from the internode of the basal bunch (Image courtesy of the AWRI Image Collection).*

For specific nutrient analysis following the application of foliar fertiliser in spring (e.g. molybdenum), shoot tip analysis is preferable. Samples should be collected at least two weeks after fertiliser application to ensure that the newly-emerged shot tips are fresh and free from contamination.

When sampling for specific nutrients or for problem diagnosis, mobile nutrients (e.g. nitrogen, phosphorus, potassium) are best analysed in older leaves. Immobile nutrients (e.g. calcium and zinc) should be targeted by sampling leaves near the growing tip of shoots.

### The timing of sampling for tissue analysis

Samples for grapevine tissue analysis are usually taken on an annual basis because vines can generally integrate the nutrient supply for the whole season. A well-defined phenological growth stage provides a means of standardising sampling time. Samples for petiole tissue analysis are usually taken at 80% flowering. For sampling later in the season, standards also exist for leaf blades sampled at veraison.

### Collection of a representative and viable tissue sample

It is important that samples are representative of the vines in the block. Each sample must be from the same variety, rootstock, age and vigour. It is also important that vines in the same sample are grown in the same soil type and are subject to the same management practices.

When collecting a sample, avoid any diseased or generally unhealthy plants, or vines that are obviously different from others in the sample. Avoid vines that

are in severe competition with weeds, areas of poor irrigation delivery or waterlogging, and where there are obvious small-scale soil variations.

For best results, samples should be collected between 6:00am and 10:00am when soil moisture and leaf turgor are optimal. Samples should not be collected during periods of climatic extremes.

Samples collected for problem diagnosis require a different procedure. A sample should be collected from the problem area in addition to a healthy sample (if it exists). The samples should be individually batched and labelled, and submitted for analysis as separate samples.

## Sample size and collection

Sufficient petioles etc must be collected to:

- Be representative of the vineyard area being analysed;
- Provide sufficient tissue for the laboratory to conduct tests;
- Provide some material in reserve for follow up testing if required.

A representative sample is usually around 100 petioles or leaf blades. If petioles or leaves are small (e.g. minimally pruned vines), a sample size of 200 is suggested.

Avoid excessive handling of samples to reduce the risk of contamination. Keep the samples cool in an insulated container during collection and transport.

## Sending samples to the laboratory

There are a few general points to remember when preparing and transporting samples for analysis:

- Collect samples into labelled paper bags (samples packaged in plastic can sweat causing concentration of nutrients and / or cause fungal growth and contamination);
- Send samples early in the week. Samples posted late in the week risk being left in freight warehouses or post offices over the weekend. If it is necessary to collect samples late in the week or over the weekend, store them in the refrigerator until reopening of business on Monday;
- All samples should be carefully labelled and laboratory forms filled in correctly, remembering to keep copies of the information sent.

Always check the sampling and storage guidelines for the laboratory being used.

IMPORTANT: Check with the laboratory to ensure that the sample can legally be sent. This is especially the case for samples sent from restricted districts (check quarantine provisions, e.g. phylloxera restrictions). All samples must follow quarantine restriction for vine material. Contact the diagnostic lab for instructions in handling samples and any specific transport and certificate requirements.

## Standards for grapevine tissue analysis

Current Australian standards for petioles sampled at flowering have been sourced from Californian data and modified in response to Australian field trials using a range of grapevine varieties. Refer to the standards provided in section 8.10. Other sets of standards are used to interpret leaf samples taken later in the season i.e. at veraison (refer to section 8.11).

## How were the grapevine tissue standards established?

The Californian petiole standards of Cook (1966) and Christensen et al. (1978) were modified by Robinson and McCarthy in 1985 following survey work in South Australia and field trials in Victoria and Western Australia (Treeby and Nagarajah- unpublished data; Goldspink- unpublished data). Flowering and veraison leaf standards are also useful (Weir and Cresswell 1993). Detailed analysis of the establishment of standards and references for the above studies can be found in Reuter and Robinson (1986).

The grapevine nutrient standards used in Australia are representative of vines grown under specific conditions. From the user's perspective they are not perfect and should be used as general recommendations to complement other nutrient management techniques. They represent parameters for optimum vine growth; however, this may not be the most important factor when managing vines for specific grape quality outcomes. It is possible to fine-tune these recommendations so that an accurate site-specific picture can be developed using regular site-specific monitoring to build a database of information.

## Grapevine nutrient sap analysis

Xylem sap analysis is widely used in a range of horticultural crops (e.g. potatoes, melons and strawberries) to monitor nutrient status (particularly nitrogen) during the growing season. There have been a number of attempts to use nitrate test-strips in vineyards; however, the fluctuations of nutrient status over time has made it difficult to apply standards.

The use of simple on-site sap testing techniques to monitor vine nitrogen levels may be beneficial. There

are two systems available that allow rapid analysis of expressed plant sap on site:

- Test strips (e.g. Merck strips);
- Cardy meters.

A simple bench top petiole sap test for nitrate and potassium can be found in section 8.12.

Comprehensive grapevine nutrient sap analysis is offered by several companies in Australia. The standards for winegrapes have not undergone rigorous research and statistical analysis, and are as yet unpublished. However, considerable effort is being made to gather sap analysis data from a wide range of varieties and regions to form the basis for standards (Pers. Comm. B. Haller). It is recommended that sap analysis be interpreted in conjunction with observations of vine growth and performance and with current soil and/or tissue analyses.

Sap analysis may be more useful if site specific records are collected over time. Remember that for these records to be meaningful, timing is critical. Samples must be collected at the same growth stage each season.

*Table 1 Grapevine leaf blade analysis standards (modified after a table from Weir, RG and Cresswell, GC 1993)*

| Nutrient (expressed as) | Sampling stage | Deficient | Low | Normal | High | Excess |
|---|---|---|---|---|---|---|
| Nitrogen (N) | Flowering | <2.5 | 2.5-2.9 | 3.0-5.0 | >5.0% | |
| | Veraison | <1.6 | 1.6-2.1 | 2.2-4.0 | >4.0 | |
| Phosphorus % (P) | Flowering | <0.16 | 0.16-0.20 | 0.25-0.40 | >0.40 | |
| | Veraison | <0.12 | 0.12-0.14 | 0.15-0.30 | >0.30 | |
| Potassium % (K) | Flowering | <0.62 | 0.6-0.9 | 1.0-1.8 | >1.8 | |
| | Veraison | <0.52 | 0.5-0.7 | 0.8-1.6 | >1.6 | |
| Calcium % (Ca) | Flowering | | | 1.2-2.8 | | |
| | Veraison | | | 1.8-3.2 | | |
| Magnesium % (Mg) | Flowering | <0.2 | 0.2-0.3 | 0.3-0.6 | | |
| | Veraison | | | | | |
| Sodium % (Na) | Flowering | | | <0.1 | 0.2-0.4 | >0.42 |
| | Veraison | | | <0.2 | 0.2-0.5 | >0.52 |
| Chloride% (Cl) | Flowering | | | <0.8 | | |
| | Veraison | | | <1.3 | 1.3-1.8 | >1.82 |
| Copper mg/kg (Cu) | Flowering | <5 | 5-10 | 10-100 | | |
| | Veraison | <5 | 5-10 | 10-300 | | |
| Zinc Mg/kg (Zn) | Flowering | <25 | 25-35 | 35-60 | | |
| | Veraison | <20 | 20-30 | 30-60 | | |
| Manganese mg/kg (Mn) | Flowering | <20 | 20-30 | 30-200 | | |
| | Veraison | <20 | 20-25 | 25-200 | | |
| Boron mg/kg (B) | Flowering | <20 | 20-29 | 30-200 | 100-200 | |
| | Veraison | <25 | 25-29 | 30-100 | 100-250 | >250 |

*Table 2 Grapevine petiole analysis standards*

| Nutrient | Test result values | | | | | Comments |
|---|---|---|---|---|---|---|
| | Deficient | Marginal | Adequate | High | Toxic | |
| N (%) | | | 0.8-1.10 | | | Use 0.9-1.25% N for vines on Ramsey rootstock. In WA use 1.7-2.2% N for Red Globe. |
| NO3-N (mg/kg) | <340 | 340-499 | 500-1200 | >1200 | | Californian possibly toxic range (>1200 mg/kg) not supported by field observation in SA, Vic and WA. In WA use 2000-4000 as adequate for Red Globe. Data should be interpreted carefully in conjunction with %N, with more credence being placed on the latter. In many cases vigour or leaf colour may provide a more appropriate index of N status. |
| P (%) | <0.2 | 0.2-0.24 | 0.25-0.50 | >0.50 | | Responsive vines in SA had values >0.1%, hence a critical value of 0.2% was suggested. For vines on Ramsey in Sunraysia use 0.30-0.55 as adequate. |
| K (%) | <1.0 | 1.0-1.7 | 1.8-3.0 | | | For vines on Ramsey rootstock in Sunraysia use <3% and 3-4.5% for deficient and adequate levels. When deficiency is suspected, sample again 6-8 weeks later, selecting the blade of the most recently matured leaf. A value of <0.5% in petiole or 0.8% in blade plus petiole confirms deficiency. WA experience (Goldspink 1996) suggest that when %N is at the higher end of adequate, adequate range for K is >1.3%. There are large differences in petiole K concentrations between varieties. |
| Ca (%) | | | 1.2-2.5 | | | |
| Mg (%) | <0.3 | 0.3-0.39 | >0.4 | | | Values are often much higher than 0.4% with no observable toxic effects. |
| Na (%) | | | | | >0.5 | |
| Cl (%) | | | | | >1.0-1.5 | Based on survey work in SA and validated in field trials in NSW (Prior et al. 1992, 1996). High petiole Cl of vines on Ramsey rootstock is indicative of water logging (Stevens and Harvey 1995, 1996). In the absence of other stresses vines appear to tolerate higher levels. |
| Fe (mg/kg) | | | >30 | | | In commercial testing laboratories petioles are not normally washed so contamination from dust will usually lead to higher values. Leaf symptoms are a more useful diagnostic aid. |
| Cu (mg/kg) | <3 | 3-5 | 6-11 | | | Values >15ppm are indicative of surface contamination with Cu sprays. |
| Zn (mg/kg) | <15 | 16-25 | >26 | | | Deficient and marginal as used in commercial tissue analysis services. |
| Mn (mg/kg) | <20 | 20-29 | 30-60 | | >500 | |
| B (mg/kg) | <25 | 26-34 | 35-70 | 71-100 | >100 | If a value in the toxic range is obtained, follow up with a blade analysis: value above 150 mg/kg is indicative of B toxicity |

Some points to consider when interpreting petiole results include:

- Boron is critical in the development of the pollen tube during flowering. Low boron levels will affect fruit set.
- Pre-flowering trace elements and fungicide sprays may contaminate the sample resulting in elevated levels, for example zinc, copper and manganese.
- Nitrate nitrogen is only one component of total nitrogen within the plant. At some stage between the beginning and end of flowering, petiole nitrate-nitrogen peaks may show large differences in concentration.

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## Further information

**Training**
For regional specific training in grapevine nutrition management, the AWRI is running *Research to Practice: Managing grapevine nutrition in a changing environment.*

**Contact**
Marcel Essling: rtp@awri.com.au for more information.

## Useful references

Nicholas, P. 2004. *Soil, irrigation and nutrition.* Adelaide: Winetitles.

Articles about grapevine nutrition and viticulture in general are available to the Australian wine industry through the Australian Wine Research Institute library. Visit http://www.awri.com.au/information_services/jfml/ for details.

Product or service information is provided to inform the viticulture sector about available resources and should not be interpreted as an endorsement.

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