viti-notes
[grapevine nutrition]

Research to Practice

Phosphorus fertilisation

Viti-note Summary:

- The role of phosphorus in grapevine function
- Mobility and availability of phosphorus in soils and the vine
- Sources and losses of phosphorus
- Managing phosphorus in the vineyard
- Application of phosphorus fertilisers
- Timing the application of phosphorus fertiliser for efficient uptake
- Environmental and sustainability issues

Other topics in this Viti-Notes series include:

- Nitrogen fertilisation
- *Phosphorus fertilisation*
- Potassium fertilisation
- Petiole analysis
- Soil acidification
- Liming
- Trace Elements

Figure 1. Symptoms of phosphorus deficiency on grapevine leaves. Symptoms include marginal chlorosis, or reddening on red varieties, which extends to the interveinal tissue. (Photo courtesy of Scholefield Robinson).

The role of phosphorus in grapevine function

Phosphorus is essential for plant growth. It is a component of cell membranes and DNA, and plays a vital role in photosynthesis, the movement of sugars, and carbohydrate storage within the vine. The reproductive processes of the vine are generally affected by phosphorus deficiency before vegetative growth is affected.

Mobility and availability of phosphorus in soils and the vine

In natural systems, phosphorus is available via the slow breakdown of organic materials in soil. With few exceptions, Australian vineyard soils are naturally low in phosphorus. The application of phosphorus fertiliser is common, especially prior to planting.

Phosphorus is taken up by vines from the soil solution in the form of soluble phosphate. It is relatively immobile in most soils so, where phosphorus has been applied, soil reserves are usually sufficient for long periods. Phosphorus is not readily leached from the root zone in most soils, but its availability is reduced when phosphorus is 'fixed' in soil by reactions with high levels of calcium, iron, and aluminium. It can also be bound to organic matter and soil particles, making it slowly available to vines.

Phosphorus is mobile within the grapevine, and can move from mature organs to areas of new growth.

Sources and losses of phosphorus

Applied phosphorus is persistent in medium-heavy soils; however, in sandy soils it is readily leached. Phosphorus may also be lost from the soil when surface soil is eroded. Phosphorus is also removed from the vineyard at harvest at a rate of approximately 0.6 kg per ton of grapes.

Managing phosphorus in the vineyard

Phosphorus fertilisers are available in three forms:

- Water soluble;
- Citrate soluble;
- Citrate insoluble.

The water soluble (and to a lesser extent citrate soluble) forms are available to plants relatively quickly. However, citrate insoluble phosphorus fertilisers, e.g. rock phosphates, release phosphorus slowly and may take years to become available to vines. The rate of release of insoluble phosphorus is dependent on soil pH. Phosphorus fertilisers which contain the highest percentage water soluble phosphorus tend to be the most expensive.

Application of phosphorus fertilisers

The application of phosphorus fertiliser in a band is generally more effective than broadcast application. Banded fertilisers are applied in a narrow strip under vines where the majority of vine feeder roots are found or between vine rows in autumn when annual cover crops are sown. Banding should always be done after weeds have been cleared. Phosphorus fertiliser is best applied in autumn or early spring to take advantage of any rain to move it into the root zone. Some forms of phosphorus can also be delivered to vines by fertigation.

Because phosphorus moves away from the point of application very slowly (except on very sandy acid soils) the application strategy must be thought out carefully to avoid phosphorus fixation. In some highly fixing soils, repeat applications of phosphorus fertiliser may be required to saturate the fixation sites on the soil particles and allow applied phosphorus fertiliser to become available to the roots. The different forms and characteristics of phosphorus fertilisers are listed in Table 1.

Table 1. Form and characteristics of phosphorus fertilisers

Phosphorus form	Characteristics
Single superphosphate	• Contains sulfur and gypsum; • High in water soluble phosphorus (readily available); • Non-acidifying.
Double and triple strength superphosphate	• Higher phosphate content than single superphosphate; • Granulated product, easy to apply; • Some have added zinc.
Mono-ammonium and di-ammonium phosphate (MAP and DAP)	• Readily soluble; • Suitable for fertigation; • Contains both nitrogen and phosphorus; • Acidifying (generally not suitable on acid soils).
Phosphoric acid	• Suitable for fertigation; • Safe handling issues; • Acidifying (may not be suitable on some acid soils).

Timing the application of phosphorus fertiliser for efficient uptake

Applications of phosphorus are not usually necessary early in the life of a vineyard, as phosphorus applied pre-planting should be sufficient to supply young vines. In the mature vineyard, the requirement for phosphorus should be determined from petiole test results.

Pre-planting

The application of phosphorus fertiliser prior to planting should be based on pre-plant soil analysis. Phosphorus fertiliser should be applied as a surface band along the proposed vine rows and incorporated into the soil. Use technical grade mono-ammonium phosphate (MAP). Alternatively, technical grade phosphoric acid (not phosphonate) may be used.

In mature vineyards

In established vineyards, periodic testing of plant tissue and/or soil is advisable to monitor reserves of phosphorus in vines and soil. If phosphorus is deficient in the soil, a high rate of application of single superphosphate in a band on the under vine bank may be required, particularly if the soil type encourages fixing of phosphorus. Such applications should not be needed frequently. Alternatively, apply a top-up fertigation with technical grade MAP at 50 kg per ha. Every few years perform an agronomic soil test of the mid row soil if a cover crop or sod is grown to determine the requirement for phosphorus fertiliser.

Adequate phosphorus is required throughout the growing season to optimise vegetative growth and production. However, because of its key role in the reproductive processes of the vine, phosphorus availability is critical early in the season to maximise yield.

Environmental and sustainability issues

There are a number of issues relating to both the sustainability of phosphorus resources in vineyards and the use of phosphorus-containing fertilisers in the greater environment. These include:

- Leaching losses from the vineyard;
- Soil acidification; this has implications for the level of accessible nutrients, soil pH, and potential for aluminium toxicity in vines;
- Phosphorus-induced zinc deficiency;
- Potential to cause algal blooms in waterways.

CAUTION: Acidification risks apply, and some irrigation waters can cause precipitation of calcium phosphate in the irrigation lines causing blockages.

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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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