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Managing Nitrogen for optimal yield and quality

Tony Hoare
AWRI

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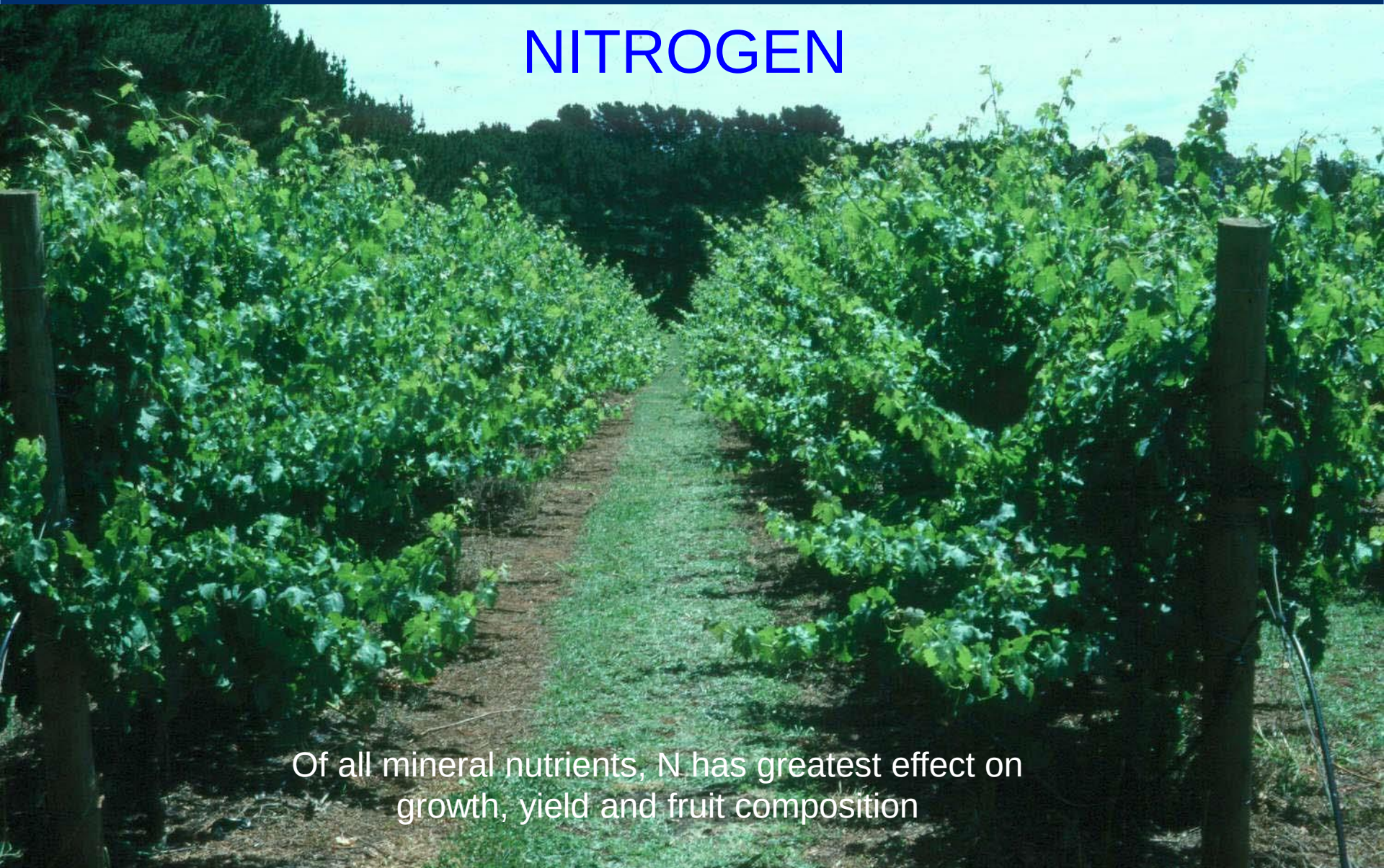
NITROGEN



Of all mineral nutrients, N has greatest effect on growth, yield and fruit composition

The Nitrogen Cycle

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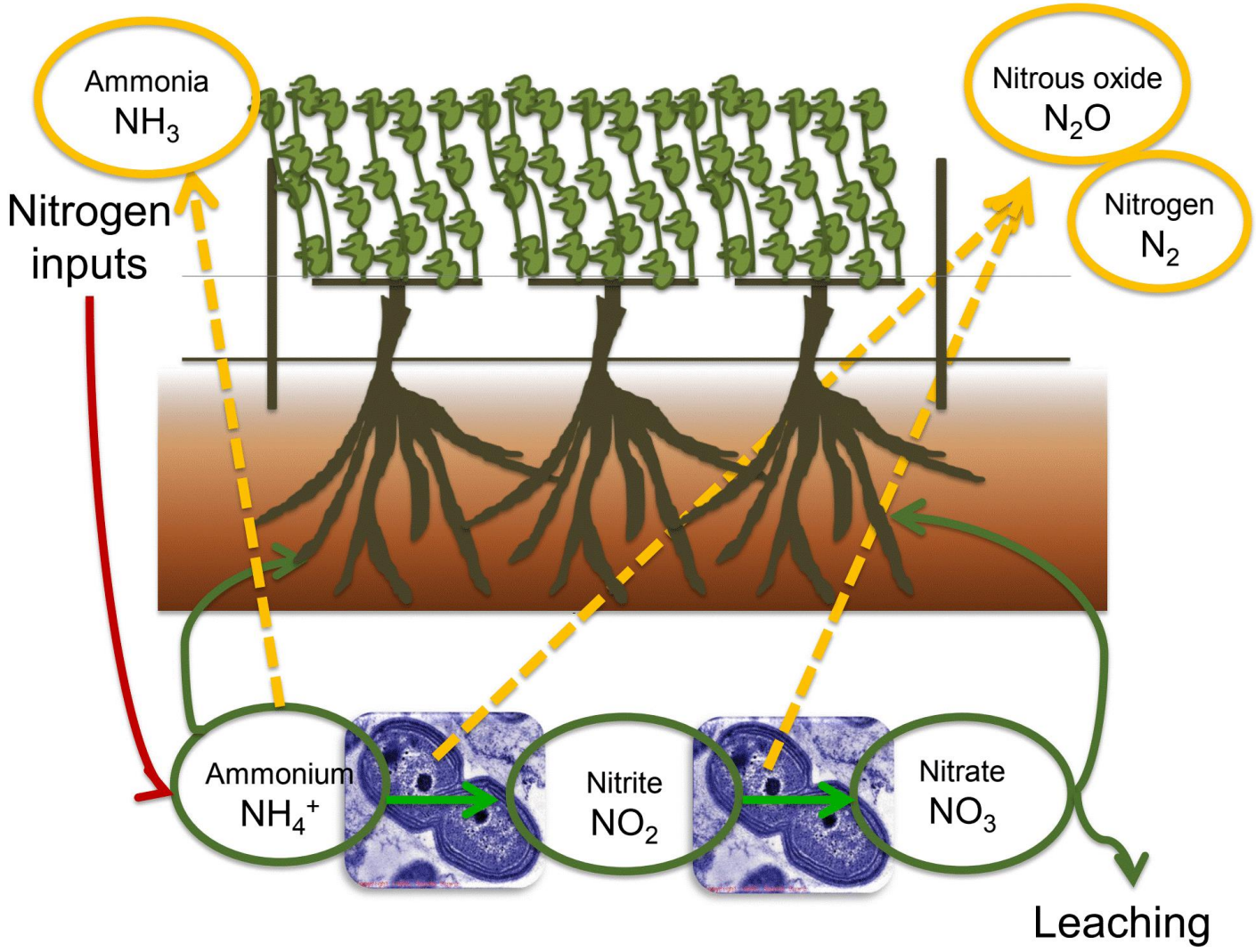

Nitrogen uptake and grapevine function

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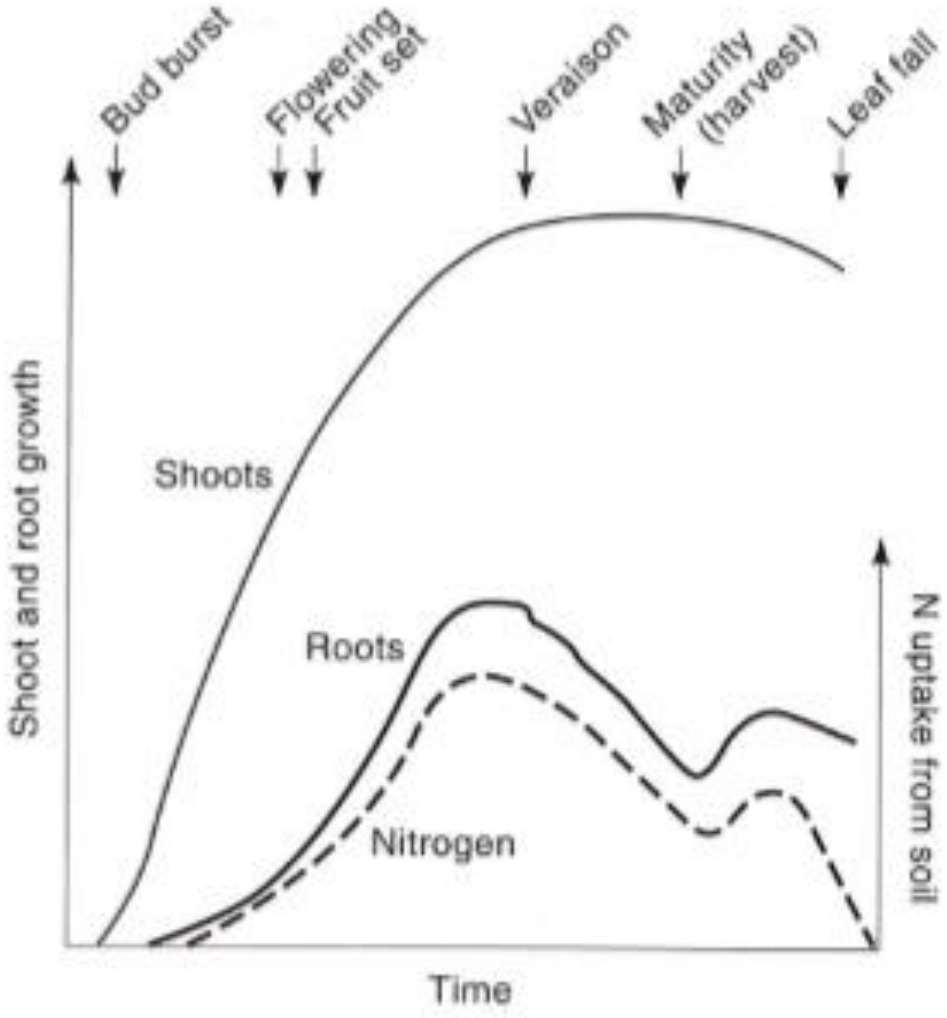

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Post Harvest – The end and the beginning

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Budburst to flowering

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Nitrogen applications – optimum timing

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Post veraison

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VitiCanopy App

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Nitrogen Loss and availability

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Assessing Nitrogen levels

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What is effect of N fertilisation on vine performance?

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Deficit to marginal status

N fertilisation generally has a positive effect

Adequate to high status

N fertilisation may have negative effect

- Disrupt balance
- Increases vegetative growth
- Increases shading
- Decreases net photosynthesis
- assimilates diverted from fruit to shoots

Nitrogen effect on fruit composition and wine quality

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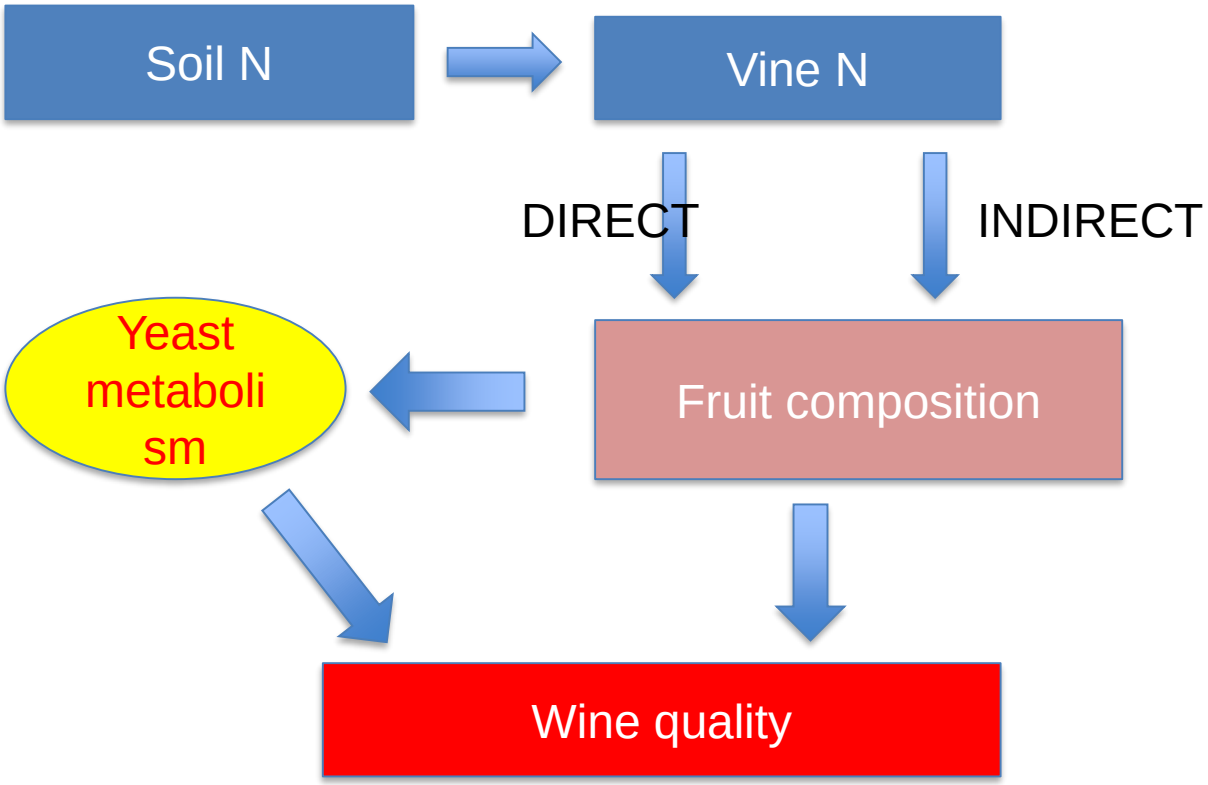

N fertilisation and red grape colour

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N fertilisation and red grape flavour

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Nitrogen fertilization and YAN

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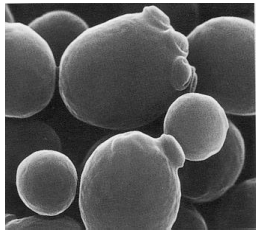
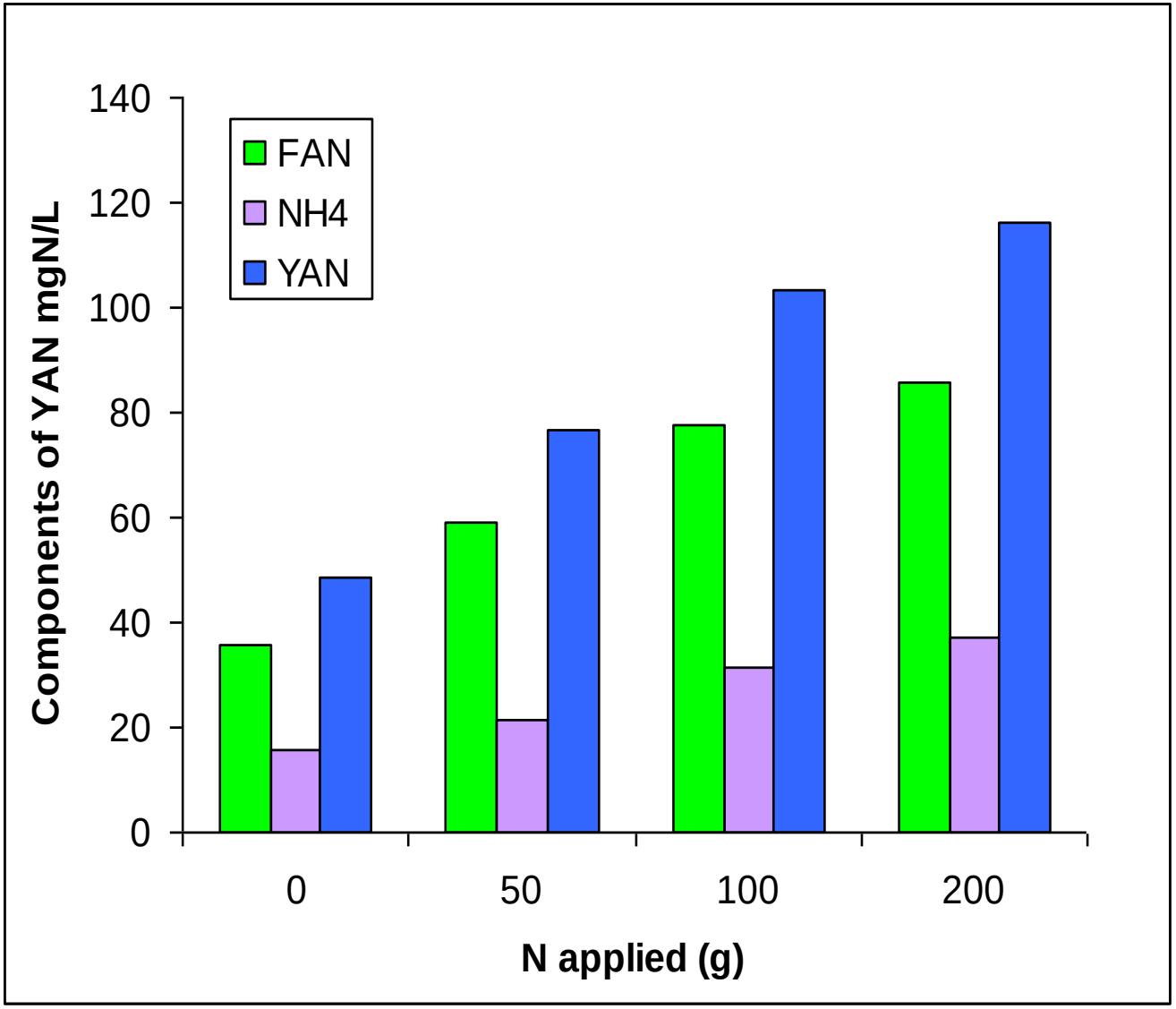


Yeast growth

Metabolic activity

- Fermentation rate
- Flavour active compounds (fermentation bouquet)



Fermentation and sensory

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Effect of juice N concentration on wine aroma

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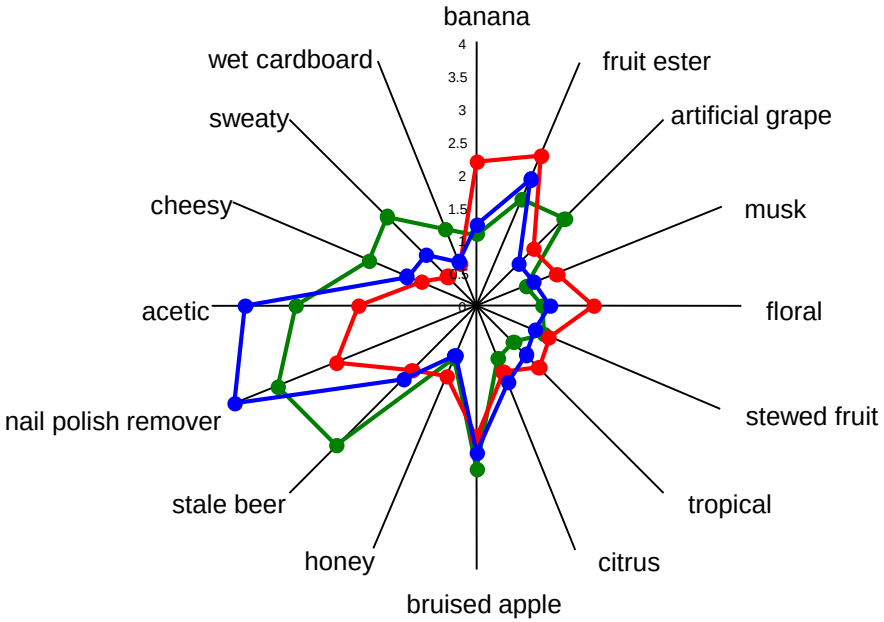

Low & High N: Negative effects
Moderate N: Positive effects

Juice YAN (mg/L): **160** **320** **480**

Effect of Juice N on Fermentation rate

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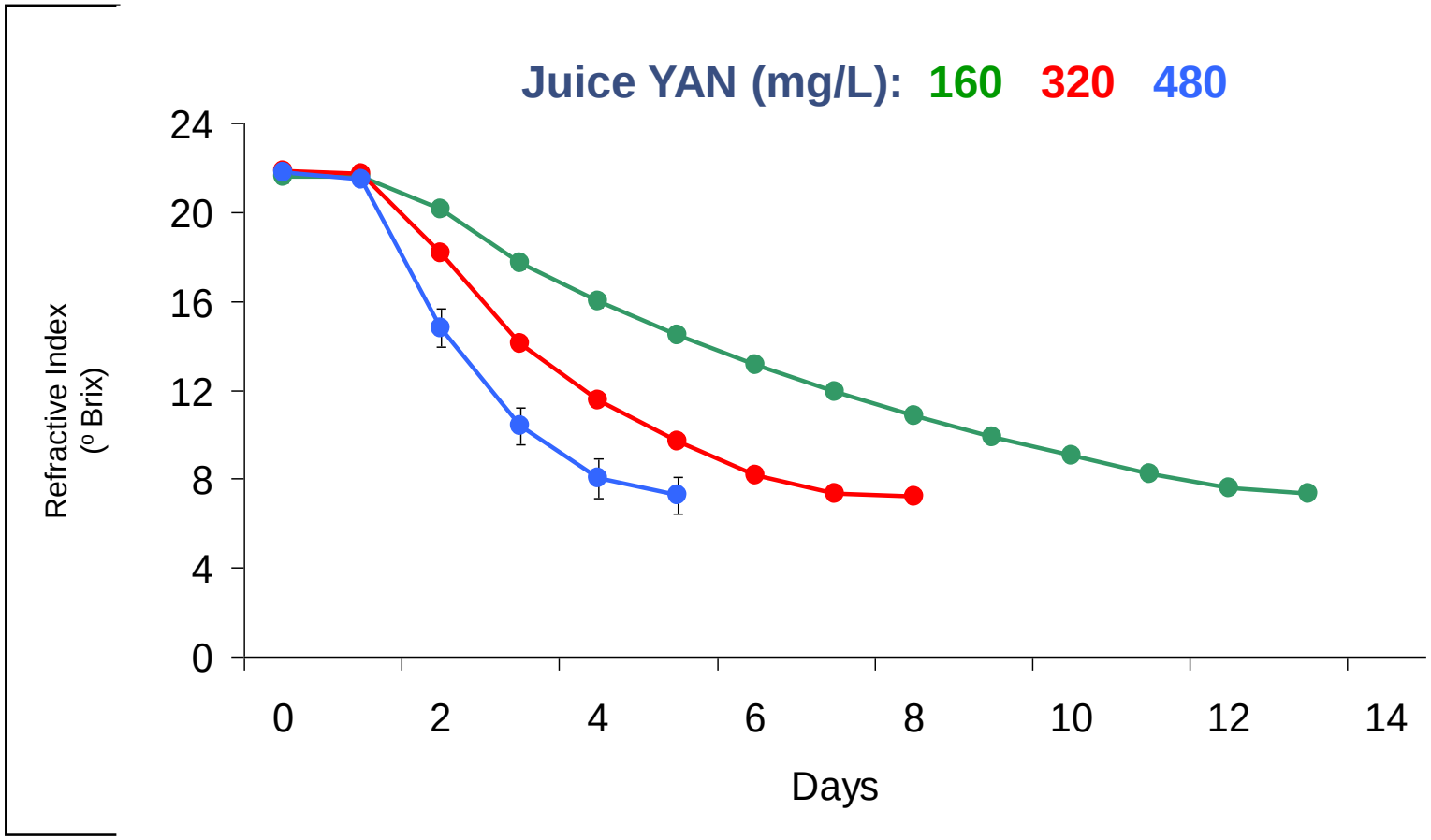

Other wine issues from high N

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Take home messages

- Post harvest Nitrogen levels are important for the following seasons yield and fruit quality
- N is the only soil nutrient that has a significant impact on wine quality
- N has both direct and indirect effects on fruit composition and wine quality.
- Observe and measure vine balance to assess N requirements.
- Only use N fertiliser to correct a deficiency or to maintain adequate levels (timing is important). Early season application can be wasted.

AWRI Website Information

The Australian Wine Research Institute

www.awri.com.au

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Vitinotes

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viti-notes
[grapevine nutrition]

Research to Practice

Nitrogen fertilisation

Viti-note Summary:

- The role of nitrogen in grapevine function
- Mobility and behaviour of nitrogen fertilisers
- Sources and losses of nitrogen
- Nitrogen management in the vineyard
- During vineyard establishment
- In mature vineyards
- Timing the application of nitrogen for efficient uptake
- Prior to budburst
- Between fruit set and veraison
- Post harvest
- Environmental and sustainability issues
- Eutrophication

Figure 1. Nitrogen deficiency sypmptoms on grapevines. Initial symptoms include leaf chlorosis on older leaves, worsening to necrosis. (Photo courtesy of Mardi L. Longbottom)

The role of nitrogen in grapevine function

Nitrogen plays a major role in all grapevine processes and a significant amount of nitrogen is essential for normal vine growth. More than any other nutrient, a deficiency of nitrogen may affect key metabolic functions and retard shoot development and bunch formation.

With a few exceptions, nitrogen is only found in moderate to low quantities in the soils of Australian vineyards. However nitrogen fertiliser should be applied to vines carefully as excessive availability of nitrogen increases shoot growth at the cost of fruit development. Over supply of nitrogen can also delay fruit maturity and may result in poor bud fruitfulness in the following season.

Mobility and behaviour of nitrogen fertilisers

Fertilisers contain nitrogen as urea, ammonium or nitrate. It is important to understand the nitrogen cycle when applying nitrogenous fertilisers so that the fate of the nitrogen can be predicted.

Urea

Urea is mobile in the soil and can be actively taken up by vines. However, it is usually broken down into to the relatively immobile form ammonia which dissolves in the soil water to become ammonium.

Ammonium

Ammonium can be taken up by vines, however, it is toxic in high concentrations. Bacteria convert ammonium into nitrite (which is also toxic to plants).

Nitrate

Nitrite is quickly converted into nitrate. Nitrate is the form of nitrogen most readily used by vines. Nitrate is readily leached through the soil profile and may move out of the root zone rapidly in free-draining soils or after heavy rainfall or irrigation.

The accessibility of nitrogen by vines relies on the presence of sufficient soil water. Water movement into vine roots transports nitrate. If soil moisture is insufficient, uptake of nitrogen will be limited. A range of factors (e.g. soil type, irrigation and rainfall) affect how the various forms of nitrogen move through the soil profile.

Nitrogen is mobile within the grapevine, and can move from mature organs to areas of new growth. As such, deficiency symptoms appear first on older leaves. Symptomatic leaves may fall prematurely (see section 4.2.10 for more detail).

Nitrogen immobilisation and the carbon to nitrogen ratio (C:N)

Immobilisation (also known as 'draw down') is a state of temporary nitrogen deficiency in soil. Immobilisation occurs when organic mulches that are high in carbon and low in nitrogen (high C:N ratio), such as vine litter, dry slashed grass or straw from cereal cover crops, are incorporated into the soil. Micro-organisms and bacteria scavenge

Other topics in this Viti-Notes series include:

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

viti-notes
[grapevine nutrition]

Research to Practice

Soil acidification

Viti-note Summary:

- Soil pH
- Soil acidification in vineyards
- Characteristics of acidic soils
- Acidifying fertilisers
- Effect of soil pH on rate of breakdown of ammonium to nitrate
- Management of acidification
- Correction of soil pH with lime
- Strategies for mature vines

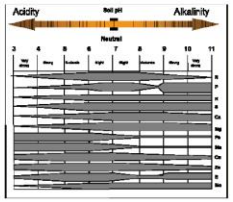

Figure 1. Effect of soil pH on availability of minerals

Soil pH

All plants and soil micro-organisms have preferences for soil within certain pH ranges, usually neutral to moderately acid or alkaline. Soil pH most suitable for grapevines is between 5.5 and 8.5. In this range, roots can acquire nutrients from the soil and grow to their potential. As soils become more acid or alkaline, grapevines become less productive. It is important to understand the impacts of soil pH in managing grapevine nutrition, because the mobility and availability of nutrients is influenced by pH (Figure 1).

Soil acidification in vineyards

Acidic soil conditions (pH < 5.5) exist in some viticultural surface soils across Australia. There are three particular situations in which acid soils are likely to present problems in vineyards:

- Planted on virgin soil which are naturally acidic, (often found in the higher rainfall areas of Australia);
- Established on old pastures which have become acidic as a result of long-term application of acidifying fertilisers, e.g. single superphosphate;
- On soils with a low capacity to resist changes in pH where acidifying nutrients have been applied.

Characteristics of acidic soils

Calcium and magnesium are displaced by aluminium ($Al3+$) and hydrogen ($H+$) and are leached out of the soil. Acidic soils below pH 6 often have reduced populations of micro-organisms. As microbial activity decreases, nitrogen availability to plants also decreases.

Sulfur availability to plants also depends on microbial activity so in acidic soils, where microbial activity is reduced, sulfur can become unavailable. (Sulfur deficiency is not usually a problem for vineyards as adequate sulfur can usually be accessed from sulfur applied as foliar fungicides).

- Phosphorus availability is reduced at low pH because it forms insoluble phosphate compounds with aluminium, iron and manganese.
- Molybdenum is seldom deficient in neutral to alkaline soils but can form insoluble compounds in acid soils.
- In strongly acidic soil (pH <5), aluminium may become freely available to plants in toxic levels. High aluminium levels stunt the growth of roots with detrimental effects on water and nutrient uptake, especially in dry conditions.
- Iron, manganese and zinc are more available in acid soils. In particular, manganese can reach toxic concentrations in acidic soils.
- Increasing soil acidity can increase the uptake of heavy metals such as copper and lead. This can be a problem in vineyards that have been planted on old apple or pear orchard soils where copper, lead and arsenic may have accumulated.

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Helpdesk services

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Contact the AWRI Helpdesk

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