The Australian Wine Research Institute

Fact Sheet
VITICULTURE

Assessing soil health in a vineyard

Introduction

As grape and wine producers become more concerned about the long-term sustainability of their vineyards and winemaking businesses, an interest in soil health has increased considerably within the wine industry. Broadly speaking, there are indirect and direct approaches to assessing soil health in a vineyard.

The indirect approach

Most wine-producing countries have established sustainable winegrowing programs that growers can access on a voluntary or membership basis; for example, Entwine in Australia. The programs vary in the extent to which soil health details are taken into account. Generally, these programs prescribe a range of soil management practices designed to improve soil health and some, such as Sustainable Winegrowing New Zealand, require soil analyses to be conducted on a regular basis. In California, 74% of wines are now certified as being sustainably produced under the program of the Californian Sustainable Winegrowing Alliance. Entwine includes a land and soil component that focuses on practices to minimise soil degradation, erosion and contamination.

The direct approach

The direct approach involves measuring soil properties that are indicative of soil health.

Two distinct situations may arise:

- Measurement of soil properties in a new site to be planted to vines
- Monitoring soil properties in an established vineyard, whether it be under current production, or being replanted with new varieties, or being rejuvenated after a period of neglect or reduced management.

A new site has the advantage that it is easy to acquire a geo-referenced map of soil spatial variability through an electromagnetic (EM38) survey. Such a high-resolution map, displayed in a Geographic Information System, enables the locations for soil sampling to be sited so that the full range of soil variability is covered. An EM survey is not as useful in established vineyards where rows are less than 2.5 m apart because steel poles and wires can interfere with the EM signal from the soil.

Soil sampling

Whether working on a new site or a rejuvenated one, excavating soil pits is an essential part of initial soil observation and sampling. Depending on the variability of the site, one or two pits per hectare should be sufficient. These can be dug with a back hoe to at least 1.2 m depth, or as deep as any underlying rock, and be at least 2.5 m long with steps for easy access. In such pits the soil colour, appearance of distinct layers (called horizons), structure and any pedological features can be easily observed. Small 'grab' samples are taken from around the pit faces at specific depths, usually one set from the A horizon (0–20 cm of topsoil) and one from the B horizon (40–50 cm in the subsoil). The samples are bulked to produce a composite sample of 1–1.5 kg for each depth. Sampling the subsoil is especially important in duplex soils (see Figure 1 in the AWRI fact sheet *What is soil health*?) where poor structure and drainage may cause problems.

In an existing vineyard, knowledge of past vine performance can be used to identify locations for soil sampling. Soil pits can be dug between the vine rows, but close to a row so that vine root growth can be studied more closely.

Monitoring over time

The initial soil sampling can indicate potential constraints on vine growth and how these might be remedied. However, one of the essential components of soil health monitoring is regular sampling over time so that trends in key soil properties can be monitored and observed. After the initial assessment, specific locations can be identified to represent larger blocks and these resampled on an annual or biennial basis. The best time for sampling is after harvest as the soil begins to wet up in autumn. Repeat subsoil sampling should not be necessary unless a particular problem, such as waterlogging or increasing salinity, is suspected.

For a productive vineyard, there is also the option of sampling leaf blades or petioles for analysis. Thirty to forty recently matured leaves should be collected in paper bags at flowering. Time of sampling is critical because concentrations of nutrients such as nitrogen (N), phosphorus (P) and potassium (K) can change rapidly as vines develop during the season.

Which properties to measure?

The best indicators are soil properties that are sensitive to management change and easy to measure and interpret. Given that a soil sample is only a very small representative of a vineyard block, for any one measurement there is always uncertainty due to field variability. Because there is also laboratory measurement error, the same laboratory using the same methods should be sought for repeat testing over time. In this way long-term trends can be established and any interannual variations downplayed, as illustrated by the trends in soil organic carbon shown in Figure 1.

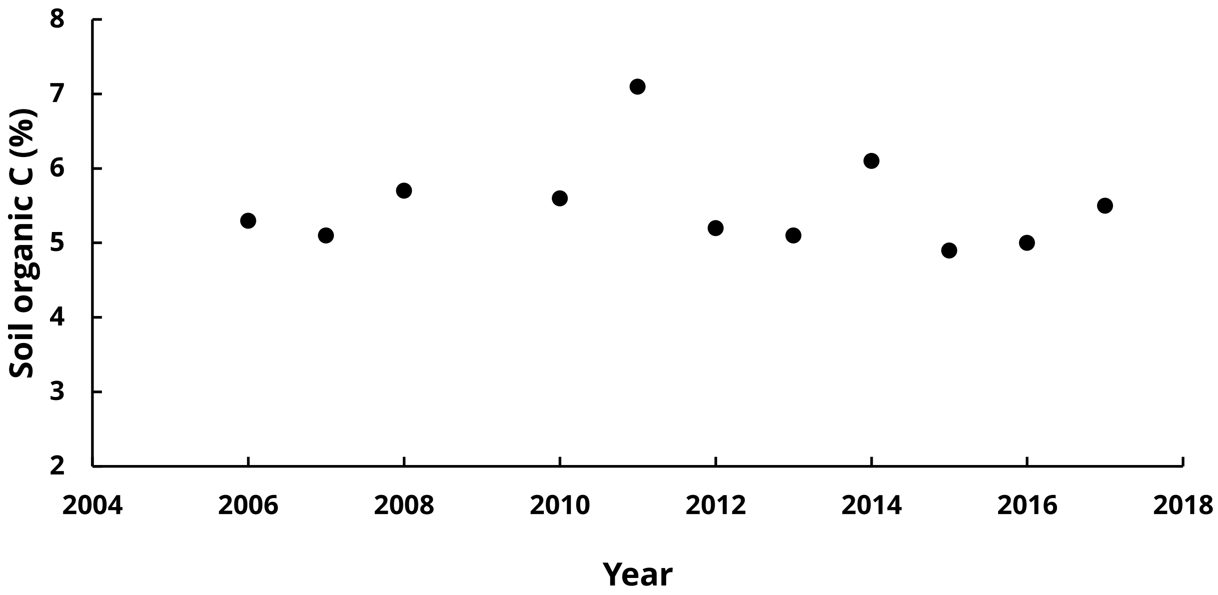

Figure 1. Trend in soil organic carbon over time

Based on large datasets, a soil testing laboratory should be able to suggest an optimum range for each nutrient, defined by a lower and upper threshold. A deficiency occurs when the soil test is below the lower threshold, while yield may be depressed or a toxicity occur above the upper threshold. Figure 2a illustrates this relationship for soil pH. For some soil properties such as salinity there is only an upper threshold above which vine growth is reduced, as shown in Figure 2b.

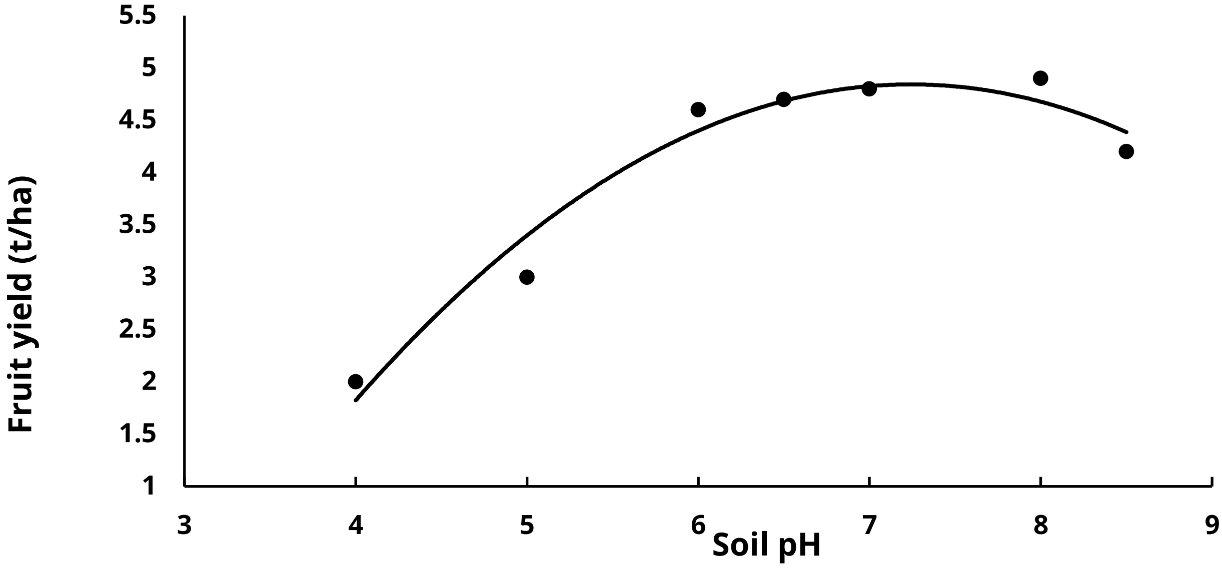

Figure 2a. Curve showing the optimum range for soil pH (water) between 6 and 8

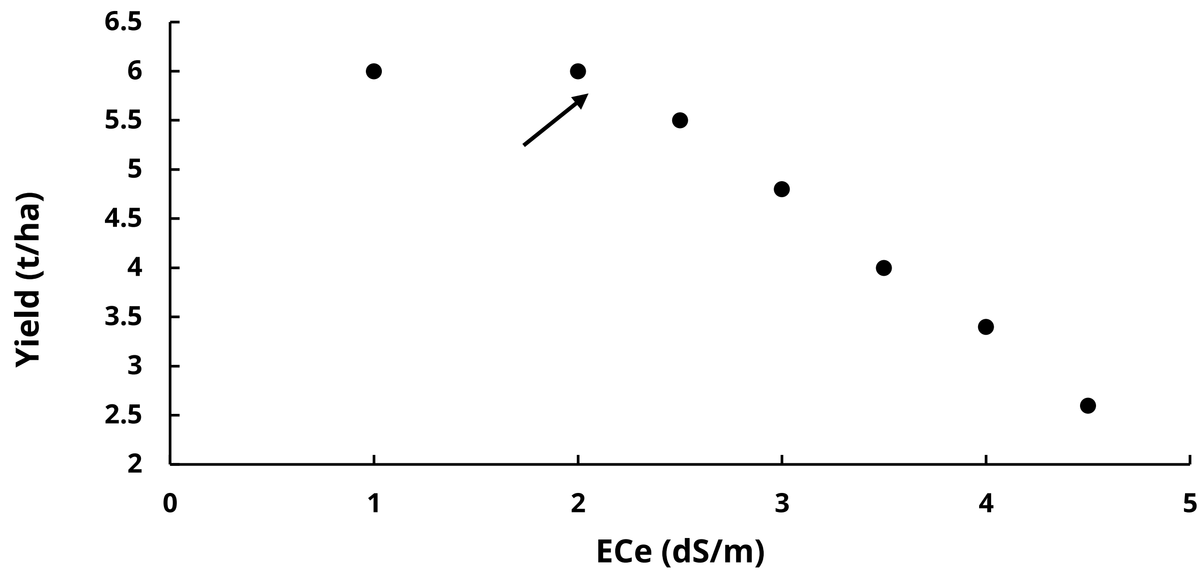

Figure 2b. Fruit yield response to increasing soil salinity measured as ECe

A suggested suite of properties to monitor soil health

As part of a soil health benchmarking study (Edwards 2014) commissioned by the GWRDC, now Wine Australia, a group of wine industry personnel and scientists recommended a set of indicators that covered the physical, chemical and biological health of a soil. These are summarised in Table 1.

Table 1. A recommended set of indicators to assess soil health in vineyards

Soil health indicator	Optimum range/ threshold value	Comments on function and methodology
Physical property		
Aggregate stability or dispersion test	Good <6 (numerical scale 0–16)	Resistance to soil crusting and erosion; related to aeration and drainage; ASWAT laboratory test (Field et al. 1997) or a field test in distilled water
Soil consistence	Good ≤3 (scale of force 0–7)	Measures the resistance of aggregates to an applied force; related to soil strength measured *in situ* with a penetrometer; soil moisture must be specified
Chemical property		
pH	6.0–8 (1:5 pH_{water}); 5.5–7.5 (pH_{Ca})[1]	Nutrient availability and plant growth; possible Al toxicity at low pH and Fe, Zn and Mn deficiency at high pH
Electrical conductivity (EC)	≤2.0 dS/m for EC_e; ≤0.3 dS/m for $EC_{1:5}$ in water[2]	Index of salinity; threshold values for $EC_{1:5}$ decrease with a decrease in clay content
Exchangeable cations (Ca, Mg, K)	Ca 60–80% Mg 15–30% K 1–10%	Macronutrient storage and availability, pH buffering capacity
Exchangeable sodium percentage (ESP)	Na <6%	Measure of sodicity relevant to clay dispersion and breakdown of soil structure
Biological property		
Soil organic carbon (SOC)	Sand >1% Loam >1.8% Clay >2%	Contributes to soil CEC and pH buffering capacity; microbial food source; improves soil structure; multiply by 1.72 to obtain soil organic matter content
Microbial biomass C	100–400 mg C/kg	The size of the soil microbial population; measurement by chloroform fumigation is expensive and tedious; surrogate estimate by substrate-induced respiration
Potentially mineralisable N	6–11 mg N/kg soil/week	N supply capacity by mineralisation; anaerobic incubation is expensive and tedious; surrogate estimate by the Solvita test (CO_2-burst)[3]

[1]See fact sheet *Measuring soil pH*

[2]See fact sheet *What is soil health*?

[3]The Solvita soil test at www.solvita.com/

Choosing what to measure

The list in Table 1 is provided for guidance. The choice of properties to measure will depend on the objectives for the vineyard and wine production. Access to soil testing services is also important, as is an assessment of the overall costs and benefits of monitoring. Different testing laboratories offer analytical 'packages' from which it is possible to select a limited number of properties to monitor, but it is important that the same laboratory is used for a period of years. In this way, soil and vine responses to viticultural management practices can be evaluated (see AWRI fact sheet *Vineyard management practices to improve soil health*).

Acknowledgement

The AWRI would like to thank Emeritus Professor Robert White from the University of Melbourne for his work in compiling this fact sheet. This work was supported by Australia's grapegrowers and winemakers through their investment body Wine Australia, with matching funds from the Australian Government. The AWRI is a member of the Wine Innovation Cluster.

Reference and further reading

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Contact

For further information, please contact the AWRI helpdesk team.

Phone 08 8313 6600 **Fax** 08 8313 6601

Email helpdesk@awri.com.au

Website www.awri.com.au

Address Wine Innovation Central Building, Corner of Hartley Grove & Paratoo Rd, Urrbrae (Adelaide), SA 5064