Soil Management

Vineyard management practices to improve soil health

This fact sheet, originally published by the AWRI, outlines critical factors in maintaining healthy vineyard soil and vines.

The AWRI fact sheet *Assessing soil health in a vineyard* emphasises the importance of mapping soil spatial variability in a vineyard and, through soil sampling, understanding what the limitations may be for growing healthy vines and producing quality fruit. Once these are understood, management actions can be taken to eliminate or moderate the limitations. These limitations can be grouped as follows:

- **Physical**, such as effective soil depth, land slope and erosion potential, stability of soil structure, aeration and drainage;
- **Chemical**, such as pH, nutrient deficiencies or excesses, salinity and sodicity;
- **Biological**, such as soil organic matter content and organisms, soil pests and disease.

Overcoming physical limitations

Effective soil depth

The effective soil depth is the depth to which roots can grow, which may be determined by an impeding rock layer or

AT A GLANCE

- The effective soil depth is the depth to which roots can grow
- Bare soil on slopes >5% predisposes a site to water erosion
- Good surface soil structure enables fast water infiltration
- Low pH can result in aluminium toxicity and high pH can cause iron, manganese or zinc deficiencies in vines
- Essential nutrients can be supplied in soluble fertilisers
- Salts accumulate in soil because water input into a vineyard is either evaporated or transpired
- Clean-cultivation of midrows and under-vine generally leads to a decrease in soil organic matter
- Soil health is promoted when there is an active chain of organisms
- The most serious soil pests are phylloxera and parasitic nematodes


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Figure 1. Vine rows in a terraced vineyard on a moderate slope.

compacted subsoil. Before a vineyard is planted, rock that is naturally fractured or weathered can be broken up by deep ripping (subsoiling), which can also be done on compacted subsoils. In the latter case, the effect of deep ripping can be enhanced by the application of gypsum (up to 5t/ha), especially if the gypsum is washed into the subsoil.

In an established vineyard, excessive wheeled traffic can cause compaction close to the vine rows, especially when the soil is wet and poorly drained. This can be avoided to some extent by confining tractor travel to alternate rows as much as possible. Machines such as the Deep Ground Probe Aerator, manufactured by Gwazae Ltd, are also available to alleviate midrow compaction.

Land slope and erosion potential

Bare soil on slopes >5% predisposes a site to water erosion, especially if the soil's infiltration capacity is low (see the AWRI fact sheet, *Measuring the infiltration rate of water into soil*). If the midrows are cultivated, terracing may be needed to control erosion (Figure 1). Erosion potential is much reduced when a cover crop is grown in the mid-rows. Permanent grass cover crops are the most effective, especially when they are grown into the vine row.

Stability of soil structure and drainage

Structural stability and drainage are complementary in the sense that good structure, especially in the subsoil, promotes free drainage and root development. Impeded drainage is revealed by 'mottling' in the soil – a pattern of orange-red patches in a paler background matrix, caused by fluctuating, reducing and oxidising conditions in the soil (Figure 2).

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Good surface soil structure enables fast water infiltration. Cover crops, especially those with deep roots such as rye grass and fescue (winter-growing) or summer-growing crops such as chicory, encourage the development of a friable and stable soil structure. Another aspect of good soil structure is an enhanced soil capacity to store available water, which is important for dry-grown vines and for successful irrigation management (see the AWRI fact sheet, *Scheduling regulated deficit irrigation*).

Structure can deteriorate from excessive compaction and through increasing soil sodicity associated with a build-up in salinity.

Figure 2. Orange-red mottles in a pale grey matrix of a poorly drained clay subsoil exposed in a profile pit face.

Overcoming chemical limitations

Soil pH

The optimum range for soil pH is between 6–8 (measured in water). Low pH can result in aluminium toxicity and high pH can cause iron, manganese or zinc deficiencies in vines. Low pH can be corrected through the application of lime that should incorporated into the surface soil (see the AWRI fact sheet, *Liming*). The amount required is at least 1–2t per ha on sandy soils, but higher (3–4t/ha) on clay soils or soils high in organic matter. Raising subsoil pH is more difficult and may require the use of hydrated lime or burnt lime. Although lowering soil pH is difficult, use of sulfur products to control powdery mildew can have a long-term effect in lowering soil pH. Soil pH in the optimum range of 6–8 generally improves biological activity.

Nutrient availability

Based on soil and/or plant testing, essential nutrients can be supplied in

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soluble fertilisers (e.g. a nitrogen (N), phosphorus (P), potassium (K) blend, with micronutrients). The amounts of the macronutrients N, P and K should balance the amounts removed in fruit and prunings or lost by leaching. Application through driplines (fertigation), although convenient, has the disadvantage of encouraging roots to develop in a confined volume of soil. Nitrogen can also be supplied by legumes such as clovers and medics grown in a cover crop. Their residues provide a slow-release form of N. In soils of pH.

Salinity and sodicity

Soil salinity may increase in irrigated vineyards, especially if the irrigation water is of poor quality (i.e. >0.8dS/m or ~500mg/L of salts). Increasing salinity can cause a build-up in exchangeable sodium and a deterioration of soil structure. Control of salinity requires that the output of salts in drainage from the root zone should balance salt input in the irrigation water. Because water input into a vineyard is either evaporated or transpired, salts accumulate in the soil. Countering this build-up requires that a proportion of the incoming water, called the leaching requirement (LR), should drain below the rootzone to flush salts away. Calculating the LR requires a knowledge of the irrigation water electrical conductivity (EC) and the critical soil EC for vines on own roots or a rootstock. The additional leaching is best achieved during winter. In some years winter rainfall provides the necessary LR.

Overcoming biological limitations

Building up soil organic matter

Soil organic matter (SOM) is the foodstuff of soil organisms, from earthworms down to bacteria. Desirable levels for soils of different texture are given in Table 1 in the fact sheet *Assessing soil health*. Clean-cultivation of midrows and under-vine generally leads to a decrease in SOM, whereas SOM is increased under cover crops, especially permanent swards, growing in the mid-rows and undervine. Cover crops can be grazed by sheep in winter, which helps to control weeds and enhances nutrient cycling.

Compost, mulches and manures also increase SOM. Compost can be made from grape marc, straw, bark chips, grass cuttings and manure (chicken, cow or pig). It is most effective when applied under-vine where the soil is kept moist and encourages the growth of soil organisms (Figure 3). Mulches of straw or bark chips are slow to decompose and therefore more effective in building up SOM than herbaceous mulches that decompose more quickly.

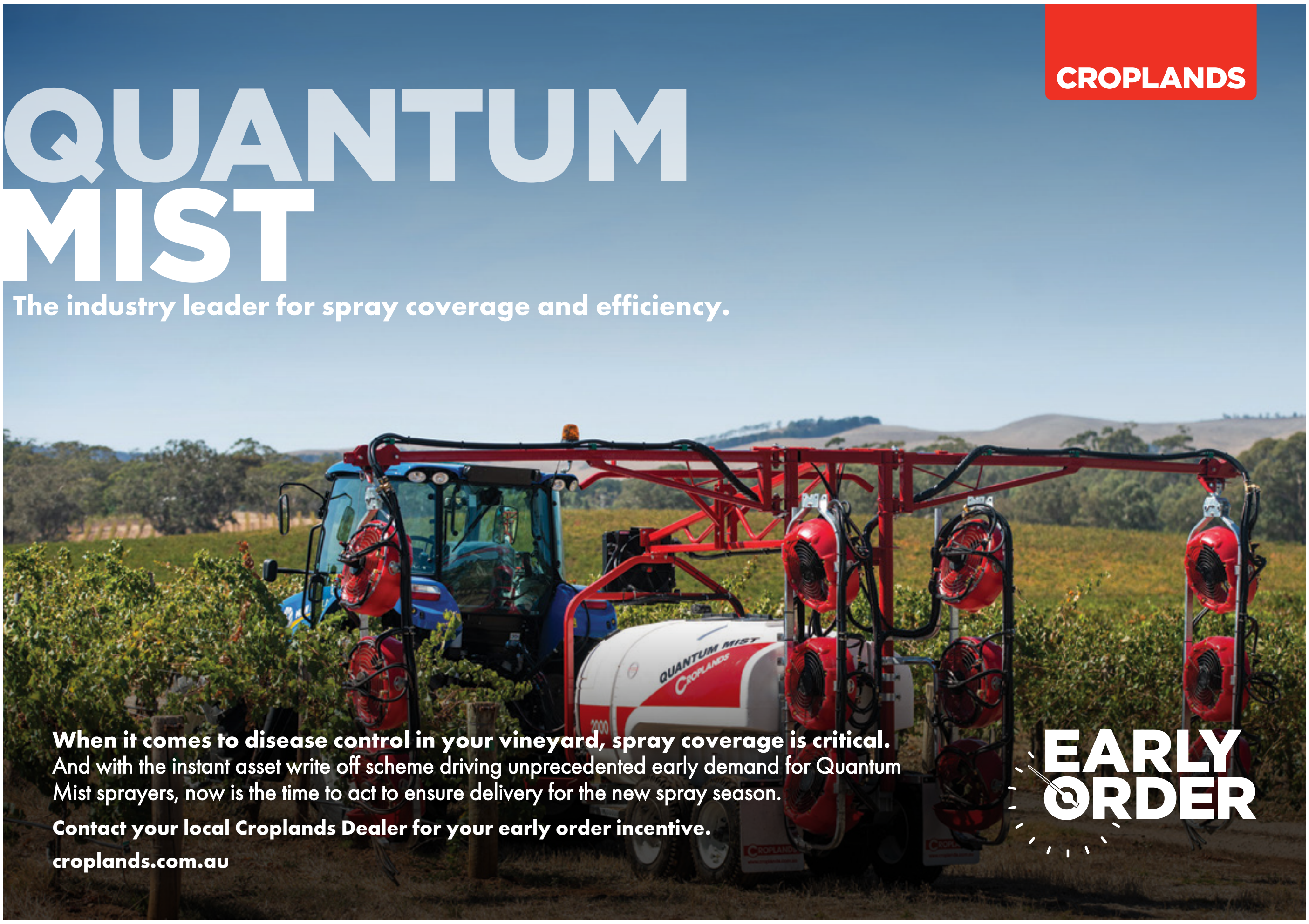

Figure 3. Dark moist soil under a straw mulch under-vine.

Diversity of organisms

Soil health is promoted when there is an active chain of organisms from the smallest (bacteria) to the largest (earthworms), described as the soil food web. This makes nutrient cycling more efficient and if the organic substrate is of low C:N ratio, mineral N is made available to the vine. The diverse population of microorganisms (bacteria, archaea, fungi, actinomycetes, protozoa and nematodes) is called the soil microbiome. A healthy microbiome stimulates mineralisation of SOM and may also produce low concentrations of growth-promoting compounds. In some cases, natural soil microorganisms can suppress soilborne bacterial and fungal pathogens and parasitic nematodes.

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Soil pests and disease

The most serious soil pests are phylloxera and parasitic nematodes. The extent of phylloxera infestation can be assessed through aerial imagery followed by ground survey and soil testing. Soil testing for nematodes requires expert identification of the pathogens, but streamlined tests based on DNA probes have potential. Nematodes may be managed through fumigation before a vineyard is planted or replanted, but such treatment can also kill beneficial nematodes and is not long-lasting. There is no effective chemical or biological control for phylloxera. The best control of both phylloxera and parasitic nematodes is provided by resistant rootstocks. Powell and Krstic (2015) give a summary of the tolerance and resistance of a range of commercially available rootstocks.

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References and further reading

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