FACT SHEET

03

WATER & VINE

Managing the challenge

MODULE 03

Sustainable salinity management in your vineyard

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These updates are supported by the Australian Government through the Irrigation Industries Workshop Programme - Wine Industry Project in partnership with the Department of Agriculture, Fisheries and Forestry and the Grape and Wine Research and Development Corporation.

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SUSTAINABLE SALINITY MANAGEMENT IN VINEYARDS

Introduction

Salinity refers to the total amount of salts present in soil or water. In Australia salinity is dominated by sodium chloride salt (closely related to common or household salt) but most soils and water also contain salts of calcium, magnesium, potassium, carbonate, bicarbonate, sulphate, borate and nitrate.

While some salts such as fertiliser can be beneficial, too much salt of any kind is detrimental to plants and other organisms.

An accumulation of salts in the root zone of grapevines can have drastic effects on growth and yield and very high concentrations will eventually kill plants. Salinity can also affect the market quality of wine. Export guidelines require wine to contain less than 1000 milligrams of sodium chloride (table salt) per litre.

Figure 1. Grapevine leaf damage caused by salt.

Evidence is growing that root-zone salinity is increasing under otherwise efficiently managed systems in many irrigation areas across Australia.

Lower Murray Darling basin irrigators are aware of the excess salts stored in the flood plain of the River Murray since the last major flooding event and acknowledge that it is important to reduce soil salinity levels as much as possible prior to the next irrigation season. There is also widespread acknowledgment of the need for growers to have a root-zone salinity measurement/management strategy for viticulture to minimise the salinity risk.

This module looks at the causes and effects of soil salinity and how it can be monitored and managed.

For more information and training contact your local Innovator's Network member or go to http://waterandvine.gwrdc.com.au.

1 The causes of soil salinity

Salts are naturally present in all soils. However additional salts can build up in the soil root-zone as a result of:

- High concentrations of salts in irrigation water or fertiliser;
- Insufficient irrigation to leach salt out of the root-zone;
- Poor soil structure that limits drainage or leaching of salts out of the root-zone;
- Non-uniform water application across the irrigated area, resulting in localised patches of inadequate leaching;
- Salinisation of the root-zone by high water tables which may bring salt from other areas or from the soil below.

2 The effects of soil salinity

A high concentration of salts dissolved in soil water can:

- Restrict a vine's ability to take up water from the soil. Both water and dissolved salts are taken up by plant roots but elevated concentrations of salt produce a high osmotic pressure, which the plant must work against to extract water from the soil.
- Have a direct toxic effect on the vine. Some salts, especially those containing sodium, chloride and boron, if taken up in large amounts have a toxic effect on plant metabolism.
- Adversely affect the physical structure of soil. High concentrations of sodium in relation to calcium and magnesium can cause clay particles in the soil to separate from each other. This produces tiny soil particles that block soil pores and limit water, air and root movement in the soil.

3 Measuring soil salinity

Salt concentration in soil is measured by the electrical conductivity (EC) of soil water or of a saturated paste extract made from a soil sample. Theoretically, the EC of the soil water (referred hereafter as ECsw) is a better index of soil salinity than the EC of the saturated paste extract or ECe. The plant roots are actually exposed to the soil water, they extract their nutrients from it, absorb other solutes from it and they consume this water through the process of transpiration. The most common unit of soil salinity is deciSiemen per metre (dS/m) where one dS/m is equivalent to one thousand EC units.

4 Soil sampling to measure soil salinity?

Standard soil sampling procedures should be followed to obtain a representative sample from different soil types or from specific problem areas on the property. In drip-irrigated vineyards, soil samples should be taken at the same depth and distance from a dripper.

Samples should be taken each year at the beginning and end of the growing season eg, in late Spring and again in Autumn. Trends should be followed over time to ensure that soil salinity is not building up and that leaching practices are effective. Soil samples taken to determine salinity levels can also be used to evaluate nutrient levels for fertiliser recommendations.

Soil water can be extracted directly from the root-zone using inexpensive equipment such as suction cups placed at different depths. Samples can be tested in the field by using a hand-held EC meter.

A suction cup is a custom designed ceramic cup glued to a short length of casing, housing an extraction tube with a two-way stopcock. It is used to extract soil water over a range of soil moisture conditions from wet (0 kPa) to relatively dry (60 kPa). Once under vacuum, the suction cup draws moisture from the surrounding soil and stores it in the inert ceramic cup. Typically, suction cups are placed at 30, 60 and 90 cm deep in a root-zone of 1 metre, and located about 15 cm from a dripper along the line of a drip irrigation system.

The advantage of using suction cups is that they allow growers to monitor salinity levels continuously, which gives a better idea of the actual variation in soil salinity as it occurs. This information can assist in making management decisions and may help prevent potential salinity problems.

One example of a commonly used commercial unit in Australia is the SoluSAMPLER™ (Figure 2) marketed by Sentek Sensor Technologies (www.sentek.com.au) in Adelaide, South Australia. A manual with installation and operation instructions for suction cups has been developed by the South Australian Research and Development Institute (SARDI) and is available from the Cooperative Research Centre for Irrigation Futures or from Sentek.


Figure 2. SoluSAMPLER

5 Soil salinity readings and salt tolerance of grapevines

A guide to general salt tolerance levels measured for wine grape varieties (expressed as SoluSAMPLERTM ECsw readings) is summarised in Table 1. ECsw values may require adjustment depending on agronomic management, irrigation salinity, soil moisture content, variety, soil type and leaching efficiency.

Crop sensitivity	Varieties	ECsw at which yield decline starts
Sensitive to moderately sensitive	Own roots (Vitis vinifera): e.g. Sultana, Shiraz, Chardonnay. Rootstocks: 1202C, Kober 5BB, Teleki 5C, S04	3.6 (dS/m)
Moderately tolerant to tolerant	Rootstocks: e.g. Ramsey, 1103 Paulsen, Ruggeri 140, Schwarzmann, 101-14, Rupestris St. George.	6.6 (dS/m)

Table 1. Guide to root-zone salinity threshold for grapevines when measured in SoluSAMPLER™ solution.

Modified from Zhang et al.2002. Australian Journal of Grape and Wine Research 8: 150-156 and R Walker, CSIRO Merbein, personal communication 2007.

6 Managing root-zone salinity in vineyards

Leaching (the process by which soluble salts are washed through or out of the root-zone by percolating water) is one way to manage root-zone salinity.

As a general rule, leaching is necessary when the average annual root-zone salinity levels are above the threshold readings for respective rootstocks and varieties as shown in Table 1.

7 Summer or winter leaching

Experience has shown that summer rainfall (or special summer leaching irrigations) are not always effective in reducing soil salinity. This may be due to water moving along preferred pathways in the root-zone during summer.

Research by SARDI suggests that winter leaching may be more effective, especially in winter rainfall zones, and that the efficiency of the leaching process can be improved by applying low rates of irrigation water onto wet soil.

A practical way to achieve this is by supplementing winter rainfall with leaching irrigations.

July is the best window for leaching salts in winter dominated rainfall areas. For other irrigation districts in Australia, the local rainfall pattern may indicate a different window for leaching particularly when soil cracking and preferred pathways are likely to be minimal. Crops are also mostly dormant, and soil evapo-transpiration is low. This minimises the chance of any upward flow in the soil profile that could counter the effect of leaching. Night leaching may further reduce soil evapo-transpiration.

8 Maximising leaching effectiveness

Laboratory studies by SARDI on soil columns indicate that several smaller irrigations on wet soil, rather than a single larger irrigation, can increase leaching efficiency by approximately 10%.

An example of an effective leaching protocol might include:

- Measuring the root-zone salinity 2-3 days after a significant rainfall event that has filled the root-zone;
- Check the reading against crop thresholds, or a target threshold that is acceptable;
- Check to ensure that further significant rainfall is not predicted in the coming 1-2 weeks;
- Apply one or several small leaching irrigations and recheck root-zone salinity a day after the last leaching irrigation.

9 Leaching Calculator

- Leaching depends on climate, soil type, crop evapo-transpiration demand and overall vineyard management.
- SARDI is developing an easy-to-use Leaching Calculator for irrigators which will be available soon.

10 Managing sodic soils?

Sodium occurring naturally or in saline irrigation water can attach to clays and where there are excessive amounts of sodium, sodicity can be an outcome. Sodicity, which can also result from excessive mechanical tillage or compaction which leads to poor soil structure, reduces water flow and restricts root growth.

The attachment of sodium to clays depends on the ratio of sodium to calcium plus magnesium which is commonly known as the Sodium Absorption Ratio (SAR). Presence of excess sodium in clay causes the particles to separate from each other and block soil pores. SAR is one way of diagnosing whether the soil is sodic. Table 2 gives the suggested critical range of SAR measures in soil water collected by SoluSAMPLER™.

If soil tests, prior to vineyard establishment, suggest the presence of sodic layers then it is recommended to add gypsum. Deep ripping will assist gypsum to reach the problem layer.

In case of secondary sodicity development after vineyard establishment, surface band gypsum every 2-3 years. In addition a cover crop (e.g. perennial ryegrass) will assist in improving soil structure.

Sodicity Hazard	SARsw	Soil microstructure stability
Non-sodic	0-9	Generally stable.
Moderately sodic	9-21	Damaged when wet.
Highly sodic	>21	Spontaneous damage from irrigation or rain.

Table 2. Suggested critical SAR.

Case study

An example of changes in soil salinity under drip irrigation with highly saline water

Data collected in the Lower Lakes district of South Australia during 2006-2007 is shown in Figure 3. Soil salinity in deciSiemens per metre (dS/m) was measured using suction cups placed at 30, 60 and 90 cm, in the root-zone of drip-irrigated grapes. Soil salinity values shown in Figure 3 are an average of the three depths. The suggested salinity thresholds for maximum grape yield are only indicative, and will differ for lower target yields and between varieties.

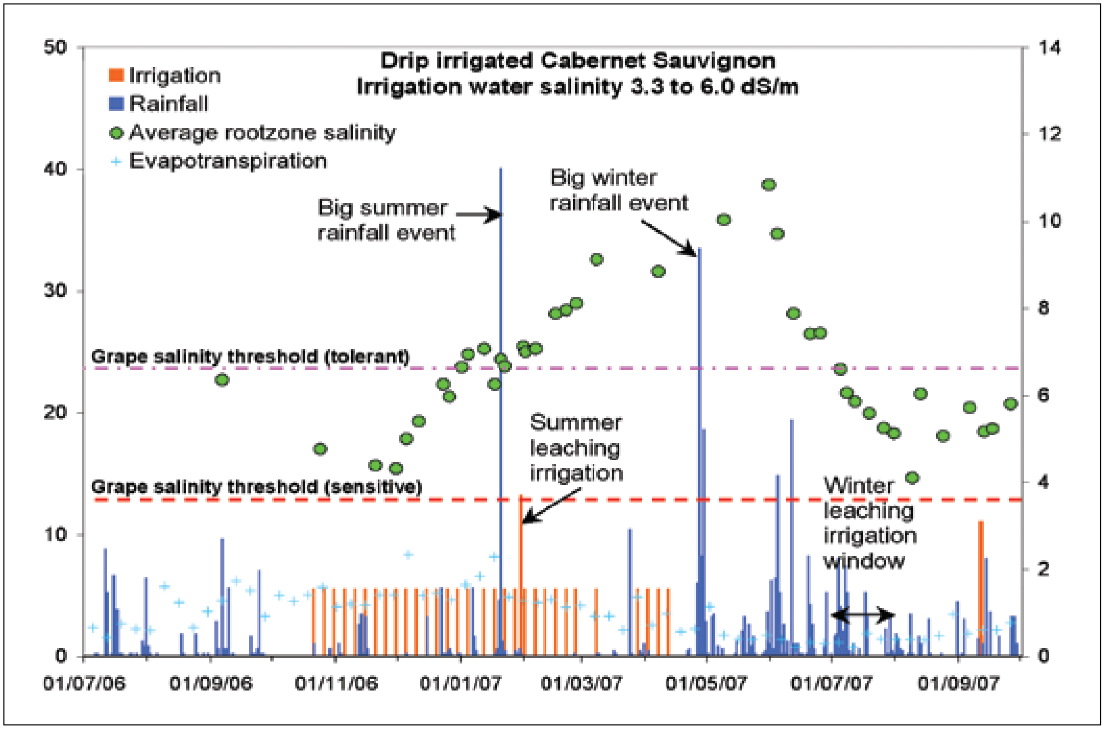

Figure 3. Changes in soil salinity under drip irrigation with highly saline water.

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