

Managing salinity with restricted allocations in the South Australian Riverland

Introduction

Under normal flow conditions, South Australian irrigators on the River Murray receive full allocations which are more than adequate for crop water requirements and salt leaching. These same normal flows also dilute the natural inflows of saline groundwater into the river, giving irrigators access to good quality water.

Inflows into the River Murray in 2007 have been at record lows. As a result, irrigators face severely restricted water allocations. At the same time, the reduced river flows provide insufficient dilution flows for the natural saline inflows, resulting in a significant rise in river salinity.



The potential impacts of this situation on irrigated horticulture in the Riverland region are outlined in *Salinity Impacts of Low Murray River Flows in the South Australian Riverland* (PIRSA Fact Sheet 05/07 - refer Further Reading section).

The Fact Sheet you are reading outlines normal salinity management strategies used by irrigators, and investigates possible management options under the restricted allocations which will apply during the 2007/08 irrigation season, and possibly beyond.

Salt Management Under Normal Water Availability

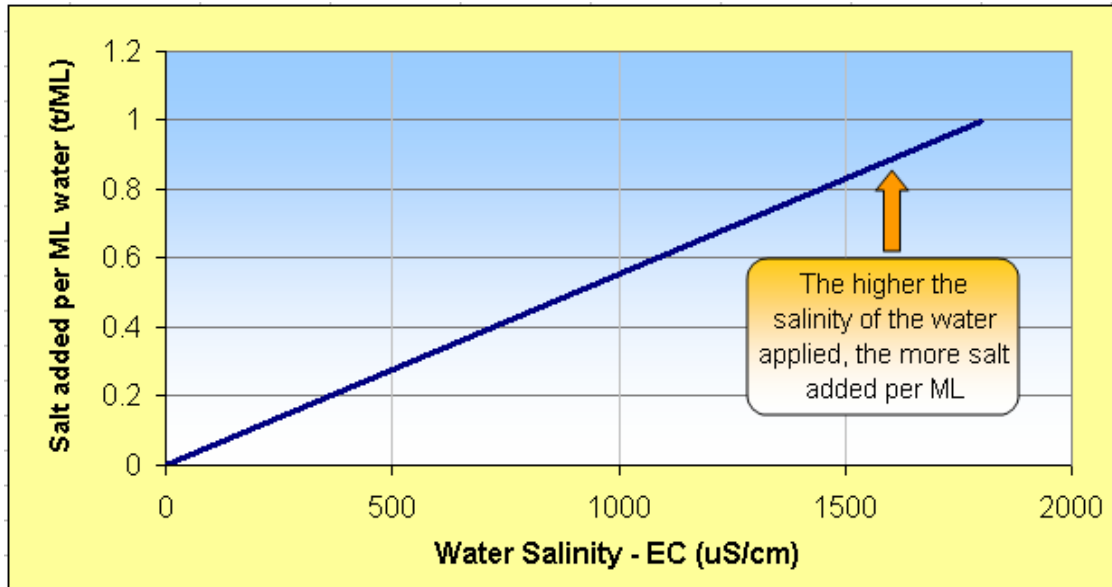
Under normal circumstances, salt is leached from the rootzone regularly, by the application of an irrigation depth greater than the soil water deficit. The extra water applied drains below the rootzone, carrying a portion of the salt with it. Regular leaching sets up an equilibrium between the salt applied by irrigation, and the salt removed by leaching, leading to a relatively constant salinity within the rootzone. Rootzone salinity will be greater than the salinity of the water applied, and will depend on the amount of leaching applied, more leaching leading to lower rootzone salinity.

The amount of leaching required, expressed as the leaching fraction, is determined from the salinity of the irrigation water and the salinity tolerance of the crop. Under normal Riverland conditions the leaching fraction for most permanent horticultural crops is around 10%. This means that out of the total depth of water applied at each irrigation event, 10% of the water should leach beyond the rootzone.

Strategies for Dealing with High Salinity and Low Water Availability

With severely restricted allocations, regular leaching is not a realistic option for most properties. The amount of salt applied depends on the amount of water applied, as illustrated in Figure 1. With restricted allocations, many planting patches will receive much less water than normal, which will have the effect of reducing the salt load. However, due to the higher salinity of the water, the total amount of salt may be just as much, or even greater than normal.

Figure 1: Salt added per megalitre of water at various salinities



▪ Leaching

Salinity management strategies are closely tied to water management strategies. If irrigation water is concentrated on a few, high priority plantings, these plantings may receive close to full irrigation requirements, and have the potential for close to normal yields. Under these circumstances it is recommended that regular leaching is practiced, and soil salinity kept low, to help the crop achieve the best possible yield and quality of fruit.

On the other hand, if the depth of water applied to patches is reduced to the point where the aim is to merely keep the plants alive, salt will accumulate at a much slower rate, due to the low water application rate. Also, it will be less critical to keep rootzone salinity low, and levels may be allowed to climb to a certain degree.

Under this strategy, it is important to remember that plants experience osmotic stress (stress due to limited water availability) as a result of both low water levels in the soil, AND high salinity in the soil water. Under the scenario outlined above, lower than normal water levels in the soil will cause some stress, and the rising salinity of the rootzone will increase that stress.

Whatever irrigation strategy is adopted, water management will rely heavily on measuring and monitoring soil salinity throughout the season, so that any leaching is targeted, only being applied when and if absolutely necessary. Measuring salinity is discussed in *Monitoring Soil Salinity for Irrigated Horticulture* and *Salinity Impacts of Low Murray River Flows in the South Australian Riverland* (PIRSA Fact Sheets 31/12/06 and 05/07 - refer Further Reading section).

▪ Avoiding Salt Uptake through Leaves

Given the susceptibility of most crops to uptake of salt through their leaves, it is strongly recommended that irrigation avoids wetting the leaves of the crop. In undertree sprinkler irrigated orchards this can best be accomplished through skirting the trees, to lift the foliage above the level of sprinkler throw.

If overhead sprinklers are used, minimise the evaporative demand during irrigation by irrigating predominantly at night, to minimise the concentration of salt on the leaves following irrigation. Slow return time on overhead sprinklers can lead to significant drying between successive wetting events, increasing the uptake of salt compared to sprinklers which return quickly and continually flush the leaves.

Some Good News Stories

The following discussion outlines some results from trial work conducted throughout the Riverland and Sunraysia districts, evaluating different aspects of irrigation with saline water. They illustrate what can be achieved with careful management.

▪ Growing Oranges

In the 1980's NSW Agriculture researcher Lynda Prior and co-workers irrigated Valencia Oranges on Sweet Orange rootstocks, using under tree sprinklers, with 2,000 $\mu\text{S}/\text{cm}$ water for 9 years. Yields were maintained at the same level as control trees, at around 50 t/ha. Saline irrigation caused a slightly increase in fruit numbers and a decrease in fruit size. They kept soil salinity below 2.0 dS/m and estimated that 53% of the applied water went to drainage.

▪ Growing Vines

In the 1990's CSIRO researcher Rob Walker and colleagues drip irrigated Sultana vines on 1103 Paulsen rootstock for 5 years with 3,500 $\mu\text{S}/\text{cm}$ water without losing yield. Average yields were 41 t/ha. Average soil salinity was high at 5.5 dS/m.

▪ Keeping Salt out of Wine

In the 1980's & 90's SARDI researcher Rob Stevens irrigated Colombard vines on Ramsey rootstock for 3 years with 3,500 $\mu\text{S}/\text{cm}$ water from early January to late March with either over head sprinklers or drippers. Sprinkler irrigated vines lost 17% yield compared to the non-saline control, whereas drip irrigated vines did not lose yield. Juice from sprinkler irrigated vines had sodium and chloride concentrations of 340 and 407 mg/L, whereas those from drip irrigated vines had sodium and chloride concentrations of 29 and 24 mg/L. Avoiding leaf wetting with saline water can dramatically reduce salt uptake.

▪ Growing Potatoes

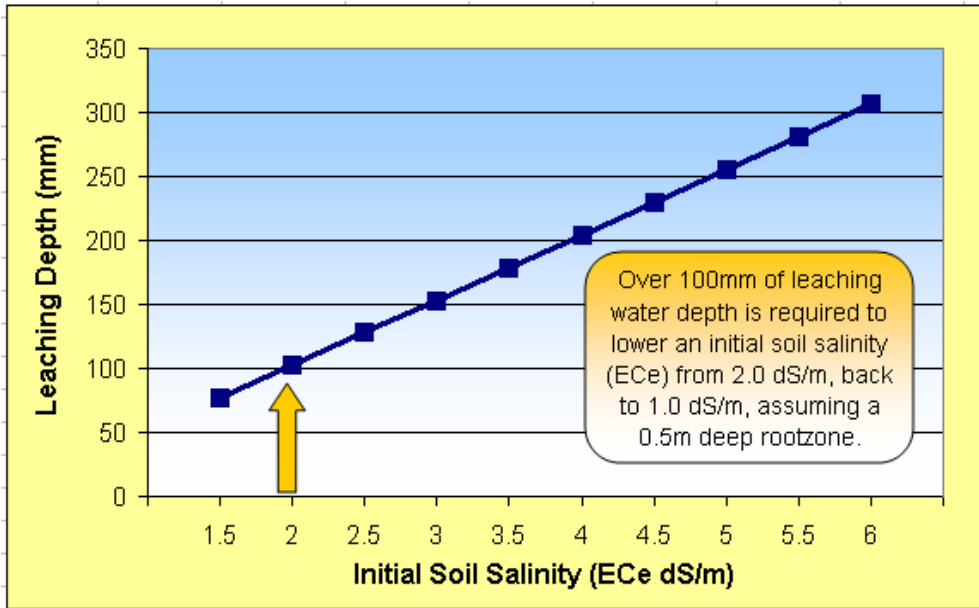
Last year (2006), SARDI researcher Jo Pech and colleagues followed up each 13 minute over canopy sprinkler irrigation of Coliban potatoes with saline water, with a 1 minute irrigation of fresh water. They increased yield by 50%, by washing the salt from the leaves before it could enter the plants.

Recovery from Salinity Impacts

A significant component of the strategy outlined above for managing high salinity and low allocations relies on the storage of salt in crop rootzones. Unless it is intentionally removed, this salt can remain in the rootzone, and continue to damage plants even once good quality water is available (either through improvement in irrigation water quality or under conditions where rainfall supplies the majority of crop water use).

It will therefore be important to leach salt from the rootzone whenever possible, given the water availability situation. However, the amount of water required to lower soil salinity is more than is often appreciated. Figure 2 illustrates the depth of leaching required to lower rootzone salinity from a range of figures back to 1.0 dS/m, assuming the rootzone is 0.5 m deep. It indicates that to lower soil ECe from 2.0 to 1.0 dS/m, for example, over 100mm of leaching is needed.

Figure 2: Leaching water depth required to return initial soil salinities (ECe) back to 1.0 dS/m



Even if this amount of water is available for leaching, this depth should not be applied in one irrigation event. Not only will this create the possibility of runoff and waterlogging, it will also not be as efficient in removing salts. More efficient leaching is achieved by applying the water in a number of smaller irrigations, separated by drainage periods. This promotes more even wetting of the soil profile, which in turn leads to more even removal of salt from the soil.

▪ **End of Season Leaching**

If inflows into storages on the River Murray continue across the irrigation season, allocations could increase late in the season. If planting patches have been set up for certain levels of irrigation and production, applying this extra water for crop use may not be particularly advantageous, and it may be more useful for leaching.

Even if this is not the case, if allocations in the following season are higher, some of this water should be used as early as possible to leach the rootzone, assisting with setting the crop up for better growth and production in that season.

▪ **Rainfall**

Rain, whenever it falls, may assist in leaching salt, depending on the soil moisture level at the time of the rain. With this in mind, it can be advantageous to irrigate in conjunction with rain, especially if the rain event is substantial. For example, if 20 mm of rain is expected, the rootzone may be filled by irrigation prior to or during the rain event, and the extra 20 mm of rain then becomes leaching. Even though this is not a large amount relative to the numbers in Figure 2, it will still carry some salt beyond the rootzone. In addition, the water applied by the rainfall event will be of much lower salinity, and therefore will add much less salt than irrigation water.

Sodicity

One issue to be aware of in regard to rainfall and salinity is the issue of sodicity. Sodicity is the breakdown of soil structure as a result of the replacement of calcium in the soil by sodium. Irrigation with water high in sodium promotes this problem. In the Riverland most of the soils are sandy in nature, and this minimises the impacts of sodicity, but heavier flood plain soils can be at risk.

The symptoms of sodicity do not appear during irrigation with salty water, as the replacement of calcium by sodium per se does not create an immediate problem. The problem comes when fresh water is applied, and sodium, being very soluble, is flushed out of the soil. This leads to the structural breakdown of soil aggregates, and characteristic slaking or puddling of wet soil. Once the soil dries, it creates a crust which can be extremely impermeable, creating runoff problems. Further information on how to determine if sodicity is a problem on your property is contained in *Assessing Soil Structure* (Cooperative Research Centre for Viticulture, VitiNote, Vineyard Activities No. 5 - refer Further Reading section)

The best defence against sodicity is gypsum. Gypsum contains calcium, which displaces the sodium, which can then be leached out of the rootzone without compromising the soil structure.

Drip irrigation is likely to be more prone to the development of sodicity problems, due to the small volume of soil used for water storage, and the even smaller surface area through which the water enters the soil. Upon the introduction of fresh water, the surface soil directly under the dripper may be more likely to develop sodicity and seal up. This will lead to runoff of water, especially on any slope, or where the soil is mounded. This will exacerbate any problems of water shortage, as the water will not be applied to the active rootzone of the crop.

The best defence therefore is to apply gypsum to the soil where the dripper output falls, preferably before fresh water is applied. The gypsum can be applied using a side spreader, to apply a continuous strip along the dripline, or a handful of gypsum can be placed at each dripper. Alternately, high grade gypsum can be applied with the water, through the drippers.

Further Reading

Monitoring Soil Salinity for Irrigated Horticulture (PIRSA Fact Sheet 31/02/06)

http://www.pir.sa.gov.au/__data/assets/pdf_file/0008/39599/Monitoring_Soil_Salinity_for_Irrigated_Horticulture_fact_sheet.pdf

Salinity Impacts of Low Murray River Flows in the South Australian Riverland (PIRSA Fact Sheet 05/07)

http://www.pir.sa.gov.au/pirsa/drought/irrigation__and__water_management/salinity_management

Assessing Soil Structure (Cooperative Research Centre for Viticulture, VitiNote, Vineyard Activities 5)

<http://www.crcv.com.au/viticare/vitinotes/Viti-Notes/vineyard%20activity%20guides/Vineyard%20activities%2005%20Assessing%20soil%20structure.pdf>

Drought Strategy Checklist (PIRSA Fact Sheet 19/06)

http://www.pir.sa.gov.au/__data/assets/pdf_file/0006/39588/Drought_Strategy_Checklist_for_Horticulture_fact_sheet.pdf

Irrigating Horticulture Crops with Reduced Water Supplies (PIRSA Fact Sheet 18/06)

http://www.pir.sa.gov.au/__data/assets/pdf_file/0007/54187/Irrigating_horticulture_crops_with_reduced_water_supplies.pdf

Water Budgeting Guidelines (PIRSA Fact Sheets for individual horticulture crops)

http://www.pir.sa.gov.au/pirsa/drought/irrigation__and__water_management/water_budgeting_and_water_trade_decision_tools

Water Budgeting & Water Trade Decisions Tools (PIRSA Spreadsheets)

http://www.pir.sa.gov.au/pirsa/drought/irrigation__and__water_management/water_budgeting_and_water_trade_decision_tools

DROUGHT RESPONSE



South Australian Government Drought Response Initiative

Drought Link website: www.service.sa.gov.au/drought.asp

Drought Hotline 180 2020 FREECALL*

*(*Mobile charges may apply. Call back available)*

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