

Salinity, sodicity and soil management under irrigated horticulture

Report of the workshop held at Robinvale on 19th and 20th September, 2019



SOIL SCIENCE
AUSTRALIA

Forty-seven people attended Soil Science Australia's joint branch workshop on "Salinity, sodicity and soil management under irrigated horticulture" at Robinvale on 19 and 20 September 2019. The workshop comprised two parts: lectures and presentations at The Euston Club on Thursday afternoon, and a tour and field trip to Select Harvest's Robinvale processing plant and almond orchard on Friday morning.

Attendees were welcomed to the Workshop by Sam North on behalf of the Riverina, South Australian and New South Wales branches. Brian Murphy (retired) then opened proceedings with a talk describing the basics of sodicity and salinity in soils and the difference between them. One of the highlights of Brian's presentation was a short video of some sodic soil (solodic soil from Mullion Creek near Orange with an Exchangeable Sodium Percentage (ESP) of 30-35%) dispersing in a petri dish of distilled water (time-lapse imagery by Vera Hong Photographics). Following Brian, Richard Greene (ANU) showed how some of the potential sources of the salt and sodium in south-east Australian soils are related to inputs carried on aeolian dust, much of which originated in the Lake Eyre Basin. Richard presented findings which predicted up to 5-10 kg/ha/yr of salt (NaCl) accumulation from dust deposits on the Central Tablelands and discussed how sodic soils can form from salt affected soils following leaching and replacement of calcium and magnesium by sodium.

Whilst the first two presentations described the basic theory underlying our present knowledge of sodicity and salinity in south-east Australian soils, the following presentations outlined efforts to manage and reclaim saline/sodic soils in irrigated lands. Luke Mosely (University of Adelaide) presented work he had done with Rob Fitzpatrick and Freeman Cook in the Lower Murray Reclaimed Irrigation Area of South Australia where they successfully showed that saline-sodic soils could be successfully recovered using low SAR water containing dissolved gypsum (i.e. Murray River water) - provided water-tables were controlled. Luke followed this with a presentation of work into the effect of 15 years of winery waste-water application on soils in the Barossa which showed a long-term build-up of potassium because of its apparent higher affinity for surfaces than sodium. Luke's description of dispersion testing via turbidity measurement and his flocculation experiments to determine gypsum requirement were of particular interest. Sam North (NSW DPI) followed Luke with a summary of work conducted by NSW DPI and Ag Victoria staff over the past 30 years to manage, control and ameliorate saline-sodic soils arising from high water-tables and groundwater use in the irrigated areas of the Murray Valley. The key take-home message here was that these problems are manageable over the long-term with gypsum applications and leaching (both rainfall and irrigation), provided water-tables are not an impediment to deep drainage.

Presentations then moved from the general to the specific, with the next four talks discussing soil, salt and water management in Riverland/Sunraysia almond orchards. Tim Pitt (PIRSA-SARDI) led with a presentation of work done to assess the salt sensitivity of mature almond trees at different growth stages. This has become an issue with the conversion to drip irrigation systems, as salts applied in a narrow wetted area are concentrating in the root zone and accumulating during dry times when there is inadequate leaching. Reducing the salt load on crops post-harvest was found to have the most beneficial effect on almond yields. The study determined that, in periods of water scarcity, early season irrigations (with salty water) are best applied to meet plant needs, with available fresh water supplies best used later in the season to leach accumulated salts if/when soil salinity thresholds are reached. Leveraging off winter rainfall was found to be particularly effective. Tim then went on to describe the use of SoluSAMPLERs as an efficient and effective method for monitoring

salt accumulation in profiles and determining when salinity thresholds are reached. This talk was a good example of how the principles of saline-sodic soil management that we have learned over the past 30 years are being applied.

Nigel Fleming (PIRSA-SARDI) described a current project looking at alternate soil management strategies under almonds. There is widespread use of organic amendments incorporated prior to planting almonds at a cost of approximately \$1000/ha, but little evidence to support its efficacy in producing “better” soils. The project is testing existing commercial practices with different application methods, comparing dripper with sprinkler irrigation systems, and revisiting Bruce Cockroft’s concept of a Supersoil. The project compares a control with 11 treatments, with 6 replicates. Nigel showed the workshop some of the “proof of concept” machines that were being tested; most notably the Farmax Spader and a sub-soil extruder for liquid injecting organic matter to depths of 0.4-0.5 m. It is only early days, but spading, drip irrigation, cover cropping and the Supersoil all look promising, though data on their production benefits are needed.

Tim Kennedy and Upul ‘Guna’ Gunnarawardane from Select Harvest wrapped up the seminar session with a more in-depth look at current water and soil management practices in almond orchards. Tim showed attendees the range of techniques and equipment used by Select Harvest to monitor crop and soil response to water and manage their irrigations. These included weather based irrigation scheduling, leaf water potential, capacitance soil water sensors, trunk dendrometers, and remote sensing. Guna followed Tim’s talk with a description of a particular issue currently affecting most almond orchards in Victoria; namely Hull Rot. This is thought to be due to nitrogen coming back into the root zone in mid-December after the spring fertigation has ceased, leading to hull split and contributing to Hull Rot. Further work is needed to confirm this and to find solutions.



Figure 1. Luke Mosely presenting to the SSA combined branch workshop at The Euston Club on the Thursday afternoon.

Proceedings finished around 5:30 and we adjourned until dinner at 6:30 in The Euston Club dining room. This was a pleasant evening, with lots of meeting and catching up to do over a good meal and a cool drink. Similarly to the Wagga Workshop back in May, this was a feature of the event as it provided a great opportunity to meet new faces, renew old acquaintances, and discuss soil and other matters. It set a great mood for the Workshop and this was carried into the Friday when we met at the Select Harvest factory at Robinvale at 8:30 am.

We were met outside Select Harvest's Carina West Processing Facility offices by David Wright, Operations Manager, who gave us a run-down of what happens at Select Harvest's almond factory (for details, see <https://selectharvests.com.au/carina-west-operations/>). He then handed over to Dan Wilson, who gave us a tour of the factory (we weren't allowed inside for obvious WHS reasons) and he described the co-gen energy (from hull burning) and almond waste recycling program. Energy produced by this facility is generated by burning hull, shell and orchard waste and provides clean power to Select Harvest's irrigation pumps, with any excess fed to the grid.



Dan and Guna described how the hull ash from the Co-Gen plant, which is high in potassium, is added to compost for re-application onto the 10,000 ha of Select Harvest orchards. This, together with the Co-Gen plant and upgrading of drip irrigation and pump systems, is part of Select Harvest's drive for sustainability. Guna showed the group Select Harvest's composting facility and outlined the trials they were currently conducting: composted BioAsh for enhancing soil structure and water holding capacity and winter banding of composts for NPK fertilisation and the effect of this banding on root biology. After this we headed back to the office for a drink (it was a warm day) and then into vehicles for a drive down the farm to look at few soil pits and get a closer look at almond orchard soil and water management.

Christian Bannan (South East Soil & Water), with assistance from Ed Scott (SA branch President and Field Systems Australia), talked us through Mallee soils via a pit dug on the top of a dune and another in swale. The following are Ed Scott's notes on the soil pits:

Two soil pits were located within an almond orchard on a classic dune-swale landscape, part of the Central Mallee Land System (Rowan & Downes, 1963). The two pits were located on areas of high and low production to contrast soil variability. The profile on the upper slope of the dune was a free-draining sand, where a deep root system to 1.0m was observed corresponding with optimal production. Soil pH was an interesting discussion point with acidity showing up in the upper 30cm of the soil profile in a land system that is traditionally relatively alkaline. Upul Gunnawardane (Select Harvest) raised the issue of the development of soil acidity following high application rates of irrigation and inputs of acidifying fertilisers.

In the swale we investigated an area that has suffered from tree death and poor yield. Upon investigation it was evident that this Loamy Sand over Light Clay profile with calcareous subsoil showed drainage issues impacting root depth. Tim Kennedy (Select Harvest) indicated that this swale and break of slope zone was subject to a significant waterlogging event in 2010 which led to the death of trees in this section.

Water and drainage management were a key point of discussion, especially in landscapes with high irrigation application and uniform irrigation systems applied across variable soil types. This highlighted the challenges in the practical application in soil and water management and irrigation design in these landscapes.



Figure 2. Christian Bannan (SE Soil & Water) and Ed Scott (Field Systems Australia) in the soil pit on the dune (left) and in the swale (right), with an attentive cast of SSA members and guests from across SE Australia.

Some useful links

Slides from Robinvale (and other past workshops) are now on the Riverina branch [SlideShare](#) site.

Details of tests and reports mentioned in the seminars (and some papers for reference)

- **Brian Murphy**
 - Aggregate Stability in Water (**ASWAT**) test
 - Field, DJ, McKenzie, DC, Koppi, AJ (1997) Development of an improved Vertisol stability test for SOILpak. *Australian Journal of Soil Research* **35**(4), 843-852.
 - **Soil Water Express** – estimating plant available water. Start with the links below:
 - [Verberg et al \(2018\)](#) Soil water – methods to predict plant available water capacity (PAWC) using soil-landscape associations.
 - **APSoil, PAWC methodology and national information:**
 - [APSoil database](#)
 - [SoilMapp](#) (soil maps, soil characterisation, soil archive and APSoil sites):
Apple iPad app available from App store
 - Use of calcium nitrate to displace sodium in soils (as suggested by Cliff Hignett)
 - [Arora & Singh \(1980\)](#) *A model for prediction of Calcium-Sodium exchange reactions in sodic soils*. *AJSR*, **18**(2), pp. 225-32.
 - [Carter & Pearen \(1989\)](#) *Amelioration of a saline-sodic soil with low applications of calcium and nitrogen amendments*. *Arid Soil Research and Rehabilitation*, **3**(1), pp. 1-9.
 - [Nielsen \(2013\)](#) *Remediation of brine-contaminated soil using calcium nitrate, gypsum and straw*. MSc Thesis. University of Manitoba, Winnipeg.
- **Richard Greene**
 - Origin of salt in SE Australian landscapes
 - Shiga et al (2011) *Recognising terrestrial-derived salt (NaCl) in SE Australian dust*. *Aeolian Research*, **2**, 215-220
 - Richard and Dennis Nettleton (USDA) worked on a transect of a similar dune and swale landscape between Tilpa and Cobar in the early 90s
 - Greene & Nettleton (1996) *Soil genesis in a longitudinal dune-swale landscape, New South Wales, Australia*. *AGSO Journal of Australian Geology & Geophysics*, **16**(3), pp. 277-287
- **Luke Mosely**
 - testing dispersion using turbidity meter
 - Rengasamy, P (2018) Irrigation water quality and soil structural stability: a perspective with some new insights. *Agronomy - Open Access Journal* **8**, 72-85.
 - Marchuk, A, Rengasamy, P (2012) Threshold electrolyte concentration and dispersive potential in relation to CROSS in dispersive soils. *Soil Research* **50**, 473-481.
 - measuring pH in sodic-alkaline soils – using CaCl₂ as an extractant in these soils can give highly misleading results (**NOTE** - Luke says keep your eyes out for a paper currently in preparation)
 - [Fitzpatrick, Mosely and Cook \(2017\)](#) *Understanding and managing irrigated acid sulfate and salt-affected soils*. University of Adelaide.
- **Sam North**

- [Rengasamy, North and Smith \(2010\)](#) Diagnosis and management of sodicity and salinity in soil and water in the Murray Irrigation region. The University of Adelaide.
- **Tim Pitt**
 - [Pitt, Stevens & Cox \(2018\)](#) Assessing the salt sensitivity of mature almond trees by replacing the resident saline irrigation with fresh water at different growth stages. Act Hort: 1219. Pp 251-258.
 - SoluSAMPLER – see [David Deery's publication](#) for instructions on how to build and install.

Program

Thursday, 19 September 2019. The Euston Club, Euston, NSW

Brian Murphy	<i>Understanding Sodic Soils – the difference between salinity and sodicity.</i>
Richard Greene (ANU)	<i>The effect of dust-borne sodium and salt on landscape processes.</i>
Luke Mosley (University of Adelaide)	<i>Understanding and managing saline-sodic and acid sulfate soils in the Lower Murray Reclaimed Irrigation Area.</i>
	<i>The effect of recycled winery waste-water irrigation on soils in the Barossa valley</i>
Sam North (NSW DPI)	<i>30 years of research into management of irrigation salinity and sodicity in Riverine Plains soils</i>
Tim Pitt (PIRSA-SARDI)	<i>Almond salt sensitivity – avoiding salt stress during critical growth stages</i>
Nigel Fleming (PIRSA-SARDI)	<i>Alternate soil management strategies in almond orchards.</i>
Tim Kennedy	<i>Technology for almond irrigation management</i>
Upul Gunnawardane	<i>Nitrogen management in Australian almonds</i>

Friday 20 September 2019. Select Harvest Carina West Processing Facility and Carina Orchard.

David Wright (Operations Manager)	<i>Select harvest almond factory</i>
Dan Wilson (Co-Gen Plant Mgr)	<i>Co-Gen energy burning (hull burning) and almond waste recycling program</i>
Upul Gunnawardane	<i>Almond waste composting</i>
Christian Bannan with Ed Scott (& others)	<i>Soil pit 1 – Dune soil</i>
	<i>Soil pit 2 – Swale soil and high water-table area</i>

Attendees

No.	Name	Organisation	Location	SSA branch
1	Sam North	NSW DPI	Deniliquin	Riverina
2	Vinod Phogat	SARDI	Adelaide	
3	Nigel Fleming	SARDI	Adelaide	
4	Cliff Hignett	Soil Water Solutions		
5	Erinne Stirling	University of Adelaide	Adelaide	South Australia
6	Brian Murphy	Retired	Swan Hill	New South Wales
7	Tim Kennedy	Select Harvest	Robinvale	
8	Upul Gunnawardane	Select Harvest	Robinvale	Riverina
9	David Rees	Agriculture Victoria		Victoria
10	Alex Schultz	NSW DPI	Deniliquin	Riverina
11	Bert Schultz	Farmer	Deniliquin	
12	Richard Greene	ANU	Canberra	New South Wales
13	Jason Condon	NSW DPI / CSU	Wagga	President, Riv branch
14	Edward Scott	Field Systems Australia	Adelaide	President, SA branch
15	Luke Mosely	University of Adelaide	Adelaide	Federal President
16	Ary van der Lely	retired		Riverina
17	John Thompson	retired	Deniliquin	Riverina
18	Sue Briggs	CSBP Soil & Plant Lab	Wodonga	Victoria
19	Alek Zander	Graham Centre / CSU		
20	Christian Bannan	SE Soil & Water	Bendigo	Riverina
21	Pat Hulme	Sustainable Soils Management	Warren	New South Wales
22	Ray Harris	ALISA		
23	Melissa Maher	Select Harvest		
24	Bryce Freundt	Select Harvest		
25	Omar Winen	Select Harvest		
26	Jeremy Giddings	Agriculture Victoria	Mildura	
27	Ben Wiblin	ABA		
28	Josh Fielke	ABA		
29	Maxine Schache	Agriculture Victoria	Mildura	
30	Natalie Mason	Agriculture Victoria	Mildura	
31	Tim Pitt	SARDI	Adelaide	
32	Scott Palmer	SLTEC	Moama	
33	Jose V. Palacios	Uni of Melbourne	Melbourne	
34	Morne Laker	New-Edge Solutions	Mildura	
35	Stefan Bekker	New-Edge Solutions	Mildura	
36	Peter Reynolds	Yenda Producers	Griffith	
37	Jarrold O'Riley	Peats Soils	Willunga	
38	Michael Treeby	Agriculture Victoria	Mildura	