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Water & soil quality

Australian cotton industry BMP

It is a cotton BMP requirement that water sources be tested for pH, salinity risks (electrical conductivity), and sodicity risks (sodium adsorption ratio). Soils need to be tested for salinity risks (electrical conductivity) and sodicity risks (exchangeable sodium percentage).

pH

pH indicates if water or soil is alkaline (pH greater than (>) 7), neutral (7) or acidic (less than (<) 7).

Irrigation Water: pH that is less than 4 can contribute to soil acidity and greater than 9 can contribute to alkaline soils. pH that is greater than 8.5 or less than 6 can affect spray mixes, result in precipitation of salts and/or cause corrosion & fouling.

Soil: Cotton prefers a soil pH in the range of 5.5 – 8.2, outside these limits, certain plant nutrients become unavailable to the plant (eg. zinc at high pH) or are released in toxic quantities (eg aluminum at low pH). Most grey clays have pH (in water) of around 8-8.5. Excessive alkalinity is associated with low amounts of organic matter and with sodicity.
Produced by the Cotton Catchment Communities CRC Environmental Extension Team

Salinity Risks

Salinity refers to the presence of soluble salts in or on soil or in water. While cotton is relatively tolerant of salt, salinity can still reduce crop yields and adversely affect soil properties. Cotton seedlings are sensitive to salinity at relatively low levels as the hormones which give tolerance are not produced until about 8-12 weeks after sowing.

Plant Salt Tolerance Grouping	Average EC_w threshold level (level at which yield reduction occurs)		
	Loam (dS/m)	Light Clay (dS/m)	Heavy Clay (dS/m)
Sensitive crops	<0.7	<0.7	<0.4
Moderately sensitive crops	0.7–1.4	0.7–1.4	0.4-0.8
Moderately tolerant crops	1.4–3.3	1.4–3.3	0.8-2.0
Tolerant crops	3.3–5.6	3.3–5.6	2.0–3.4
Very tolerant crops	5.6–8.9	5.6–8.9	3.4–5.4
Generally too saline	>8.9	>8.9	>5.4
Cotton (seedling thresholds are much lower)	6.9	6.9	4

(1 dS/m = 1mS/cm = 1000µS/cm = ~640 mg/L of salt)

Table 1 Average EC_w threshold level for irrigation water (adapted from NR&M Facts Water Series W55

Irrigation Water: Electrical Conductivity (EC_w) measures the concentration of salt in irrigation water. The effect water salinity has on plants depends on soil type; salt tends to stay longer in the root zone and harm plants in slower draining soils. High salt levels can also be detrimental to stock and the environment. Environmental

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Susan Maas and Veronica Chapman, December 2005

impacts may occur around 1.5dS/m.
If a problem or risk is identified, water held in on-farm storages should also be tested for suitability, as evaporation of water can increase salt concentration. Groundwater is prone to higher salinity and should be monitored regularly. Chloride concentration should also be monitored.

Soil: Early indicators of soil salinity include poor crop growth, increases in salt tolerant weeds and prolonged wetness and/or unusually friable soil structure in low lying areas. Severe symptoms can include bare, salt-encrusted soil surfaces, unusually clear water in puddles and drains (due to flocculation of clay particles), greasy-looking black patches ('black alkali') due to dispersion of organic matter and total crop failure.

Electrical conductivity (EC) is also used to measure salinity in the soil. Saturated Extract (EC_e) is conducted by a laboratory.

Yield decline for adult cotton plants starts at around 7.7dS/m, however early season salinity above EC_e1.5 dS/m can have detrimental effects on cotton yields.

$EC_{1:5}$ is a simpler approximate and can be conducted in the field, however this procedure does not take soil texture effects into account (see Waterpak5.3 for conversion based on percent clay).

Sodicity

Sodicity is an excess of exchangeable sodium which can result in the degradation of well structured soils through clay dispersion. The surface soil crusts or sets into hard blocks on drying. Excessive clay swelling and pore blockages, and reduced permeability to water and air are a sign of sodicity.

Irrigation Water: Sodium Adsorption Ratio (SAR) measures the relative concentration of sodium (Na) to calcium (Ca) and magnesium (Mg) in irrigation water. If requested this will be provided by the laboratory, or can be calculated from the following equation (where Na, Ca & Mg are expressed as milliequivalents per litre (meq/L)):

$$SAR = \frac{Na^+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$$

Plant Salt Tolerance	Saturated Extract, EC_e (ds/m)	1:5 soil:water suspension, $EC_{1:5}$ (dS/m)		
		Silt loam	Medium clay	Heavy clay
Sensitive (eg field peas)	<1.5	<0.16	<0.20	<0.26
Moderately sensitive (eg lucerne, **early cotton**)	1.5-3.0	0.16-0.32	0.20-0.40	0.26-0.52
Moderately tolerant (eg cowpea)	3.0-6.0	0.32-0.64	0.40-0.80	0.52-1.04
Tolerant (eg **cotton**, wheat, sorghum)	6.0-10.0	0.64-1.05	0.80-1.33	1.04-1.72
Very tolerant (eg saltbush)	>10.0	>1.05	>1.33	>1.72

Table 2 Soil conductivities at which yield decline starts (Table modified from SOILpak C7-1)

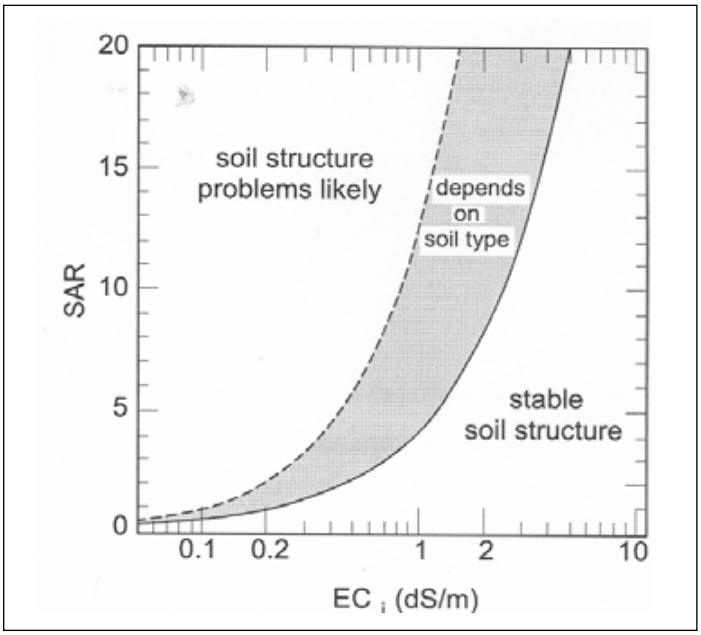

Figure 1: Relationship between SAR and EC of irrigation water for prediction of soil structural stability (from ANZECC Water Quality Guidelines Figure 4.2.2)

Superimpose the EC_w and the SAR onto the graph in Figure 1 to evaluate the sodicity risk of irrigation water. Water that falls to the right of the solid line is unlikely to cause soil structural problems. If it is to the left of the dashed line it is likely to induce degradation of soil structure and corrective management will be required. Water that falls between the lines is of marginal quality and should be treated with caution.

Soil: Exchangeable Sodium Percentage (ESP) is performed in a laboratory and can help to identify sodicity problems in the soil.

A soil with an ESP greater than 5 is referred to as sodic although ESP values as low as 2 can cause soil structure problems if the concentration of salt in the soil solution is very low.

$EC_{1:5}$ / Exchangeable Na is considered a better indicator of sodicity in cotton-growing soils, with values below 0.15 indicating structural instability. The ASWAT dispersion test (SOILpak C4-15) can be used to identify areas of concern to be tested.

Further information

- Australian Cotton Production Manual
- SOILPak E3 - Effects of Sodicity & Salinity on Soil structure
- SOILPak C4 – Structural Conditions
- SOILPak C7 – Salinity
- SOILPak D7 – Achieving a suitable pH
- WATERPak Section 5 Managing Soil & Water (includes how to sample water)
- NUTRIPak 7-01 – Soil Sampling & analysis.

Where to find Water Quality Monitoring data:

NSW department of Primary Industries Office of Water
Real time and historical water monitoring data for rivers and streams and groundwater bores in NSW
www.realtimedata.water.nsw.gov.au/water.stm

QLD Department of Natural Resources and Mines
Real time and historical water monitoring data for rivers and streams and groundwater bores in QLD
www.dnrm.qld.gov.au/water/water-monitoring-and-data/portal

Murrumbidgee Irrigation Scheme
Water quality monitoring data for the Murrumbidgee Irrigation scheme
www.mirrigation.com.au/Environment/Water-Quality

Fitzroy Partnership for River Health
Provides an annual report card for river water quality data in each catchment within the Fitzroy Basin. Also provides a portal where growers and the community can add water quality data.
www.riverhealth.org.au/report_card/methods/data/