SOIL TEST METHODS & GUIDELINES FOR INTERPRETATION OF SOIL RESULTS

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pH

There are two standard pH tests in the report. pH (water) is measured in a 1:5 soil/water suspension. pH (calcium chloride) is measured in a 1:5 soil/0.01M calcium chloride suspension. pH (calcium chloride) is normally 0.5 - 1.2 units lower than pH (water).

Criteria – pH (water)

Strongly acidic	≤ 5.4	Slightly alkaline	7.1 - 7.5
Moderately acidic	5.5 - 6.4	Moderately alkaline	7.6 - 8.3
Slightly acidic	6.5 - 6.9	Strongly alkaline	≥ 8.4
Neutral	7.0		

EXTRACTABLE PHOSPHORUS (Colwell) (mg/kg)

A 1:100 soil/0.5M sodium bicarbonate extract is shaken for 16 hours and the phosphorus concentration determined by colorimetry.

Criteria

	Crops		Pastures	Potatoes	Other Vegetables	Vines/apples
	Non-calcareous	Calcareous				
Very Low	<10	<15	<10	<20	<40	
Low	10 - 20	15 - 25	10 - 18	20 - 40	40 - 80	
Marginal	20 - 30	25 - 35	18 - 25	40 - 55	80 - 120	
Adequate	30 - 45	35 - 45	25 - 45	55 - 100	120 - 150	>80
High	>45	>45	>45	>100	>150	

These figures are a guide only. Actual phosphorus requirements will be based on crop yield, stocking rate, production targets as well as soil phosphorus status.

EXTRACTABLE POTASSIUM (mg/kg)

Identical extraction method as used for phosphorus. The concentration of potassium is measured by flame atomic absorption.

	Permanent pastures	Potatoes	Other vegetables
Low	<80	<120	<150
Marginal	80 - 120	120 - 250	150 – 250
Adequate	120 - 250	>250	>250
High	>250		

EXTRACTABLE SULPHUR (mg/kg)
(KCl-40)

Soil sulphur is extracted with 0.25M potassium chloride heated at 40°C for 3 hours. The sulphur concentration is determined using an ICP spectrometer.

Criteria (for permanent pastures)

Low	<5
Marginal	5 - 10
Adequate	>10

These values are a guide only. Rainfall, soil type, crop type (eg canola) and past fertiliser history are important factors to take into consideration when estimating sulphur requirements.

ORGANIC CARBON (%)
(Walkley/Black)

Organic carbon is measured by digestion in strong acid/dichromate solution and the colour development assessed against standard sucrose.

Criteria

Texture	Low	Moderate	High
Sand	<0.5	0.5 - 1.0	>1.0
Sandy loam	<0.7	0.7 - 1.4	>1.4
Loam	<0.9	0.9 - 1.8	>1.8
Clay loam/clay	<1.2	1.2 - 2.0	>2.0

SALINITY
The electricity conductivity (EC) of the 1:5 soil/water suspension is measured and the results are expressed in decisiemens/metre (dS/m).

The value for EC (1:5 soil/water) is converted to an **estimated** electrical conductivity of a saturation paste extract (ECe) by multiplying by a texture factor.

Note: dS/m are the same units as mS/cm.

Criteria	ECe (estimated)
Low salinity	0 - 2
Sensitive plants affected	2 - 4
Many plants affected	4 - 8
Tolerant plants affected	8 - 16
High salinity	>16

Use the salinity fact sheet for the tolerance of various crops and pastures

FREE LIME
1 N hydrochloric acid is added to the soil and the degree of effervescence is evaluated. The following categories are defined.

NIL, SLIGHT } Non-calcareous

MODERATE, HIGH, VERY HIGH } Calcareous

TEXTURE
Assessed using field texturing techniques. The following classes are reported.

SAND
SANDY LOAM
LOAM
CLAY LOAM
CLAY
HEAVY CLAY

NITRATE NITROGEN (mg/kg)
Extracted with 1:5 soil/1.0M potassium chloride for one hour.

Tentative guide only

<5 considered low – nitrogen applications should be determined by yield expectations, crop type, soil type, rainfall, past and present management factors etc.

ION-EXCHANGE PROPERTIES
Physical and chemical properties of most soils are influenced by their ion-charge characteristics, including the amount and balance of individual ions. Of particular importance are the **exchangeable cations** (calcium, magnesium, sodium, potassium and aluminium) and the **cation exchange capacity**.

CATION EXCHANGE CAPACITY (CEC)
(mequiv/100)

The CEC is a measure of the soils ability to hold cations. In surface soils the cation exchange capacity is associated with clay content, organic matter and type and retention of cations. The higher the CEC the higher the potential fertility of the soils.

Where total cation exchange capacity is less than 5 this indicates low inherent fertility of the soil.

The presence of salts, gypsum or lime can lead to over estimation of exchangeable cations and hence CEC. The CEC in this procedure is calculated by adding the 5 cations and as such is the **EFFECTIVE CEC**.

EXCHANGEABLE CATIONS (mequiv/100 g)

(calcium, magnesium, sodium, potassium, aluminium)

No pretreatment for soluble salts. The soil is extracted at a ratio of 1:10 with (0.1M ammonium chloride/0.1M barium chloride) for two hours.

Desirable levels of individual cations vary for crops and soil type. As a general guide for vegetables on loamy soils, adequate levels for exchangeable calcium are 6.0 – 7.5 mequiv/100g and exchangeable magnesium are 1.6 – 2.0 mequiv/100g.

Adequate levels are considerably less for sandier soils.

Cation ratios
(all calculated ratios are based on figures in mequiv/100g)

Cation ratios are the percentage of the total cation exchange capacity which are attributed to that particular cation.

A guide to desirable ranges are:

Exch. Calcium	65 – 75%
Exch. Magnesium	10 – 15%
Exch. Sodium	0 – 4%
Exch. Potassium	3 – 8%
Exch. Aluminium	0 – 5%

For brassicas and apples it is important to aim for a calcium/magnesium ratio 3.5:1 to 5.5:1.

If the ratio of calcium:magnesium is <2 structural problems may occur in some soils.

Grass Tetany (hypomagnesia)

The ratio of $\frac{\text{Exch. Potassium}}{\text{Exch. calcium + Exch. Magnesium}}$ can be used as an indicator of potential grass tetany. On soils where this ratio is > 0.07 to 0.08 grass tetany may occur. Plant tests need to be used to confirm grass tetany potential.

Exchangeable Sodium Percentage (ESP)
ESP is used to indicate if soils have sodic properties ie: the cation exchange complex is saturated with too much sodium. Sodic soils are often dispersive with poor structural characteristics.

Classification:	<6%	non sodic
	6-15%	sodic
	>15%	strongly sodic

If soils are sodic or strongly sodic and disperse, an application of gypsum should improve stability in the short term.

EXTRACTABLE TRACE ELEMENTS

(mg/kg) (copper, zinc manganese, iron))
Extracted with 1:5 soil/0.02M EDTA (pH 4.9) for one hour.
Plant analysis is the preferred method of determining trace element deficiencies. Soil testing interpretation is difficult as critical concentrations vary between soil types and plants. Suspected deficiencies should be confirmed by using plant analysis. Manganese and iron are less available in high pH calcareous soils, resulting in low values.

Extractable Copper (mg/kg)
For pastures 0.5 is low and 1 - 2 adequate. For intensive crops (eg Vegetables) 4 is adequate.

Extractable Zinc (mg/kg)
For pastures 0.7 is low and 1.2 - 2 adequate. For intensive crops 4 adequate,

Extractable Manganese (mg/kg)
As a general guide < 10 is low and > 50 high for manganese. No critical concentrations have yet been established.

EXTRACTABLE ALUMINIUM (mg/kg)

Extracted with 1:5 soil/0.01M calcium chloride solution for one hour.

Extractable aluminium closely follows the pH of the soil and becomes a problem when the pH (water) is less than 5.5 (in soils which contain significant aluminium). Where extractable aluminium is > 4, sensitive plants will be affected. Agricultural lime which raises pH will therefore reduce high extractable aluminium.

EXTRACTABLE BORON (mg/kg)

Extracted with 1:2 soil/0.01M calcium chloride solution, refluxed for 10 minutes.

Boron deficiencies may occur if extractable boron concentrations are <0.5 in most crops or <1.0 in crops with high boron requirements eg brassicas. Boron toxicity may occur in sensitive crops if > 5. Toxic layers frequently occur at depth. For cereal crops the most reliable indicator for boron toxicity is analysis of the grain.

CHLORIDE (mg/kg)

Extracted with 1:5 soil/water for one hour.

Critical levels for salinity are:

120 sands to sandy loam

180 loam to clay loam

300 clays.

Above these figures salinity damage may occur depending on soil drainage and plant tolerance.

Adequate Soil Levels For SL - CL Soils

Under High Rainfall – Acid – Neutral Conditions

For interpreting The Option D Soil Test

Test	Units	Extensive Grazing	Intensive Grazing	Vines Olives	Apples	Intensive Vegetables	Potatoes (Field)
PH (Water)		5.8 – 6.3	6.0 – 7.0	6.0 – 7.0	6.0 – 7.0	6.2 – 7.0	5.5 – 7.0
PH ($CaC1_2$)		5.0 – 5.5	5.2 – 6.2	5.5 – 6.5	5.5 – 6.5	5.5 – 6.5	5.0 – 6.0
Ext P	mg/kg	25 – 30	30 – 45	50 – 60	80	120	55 - 100
Ext K	mg/kg	100 – 120	120 – 150	200	200 – 250	250	250
Ext S	mg/kg	6 – 8 Sandy soils More prone	>6 - 8	>10 – 15	>10 - 15	>15	>10 - 15
Organic C	%	>1.0 S >1.5 SL >2.0 L&C	>1.0 S >1.5 SL >2.0 L&C	>1.0 S >1.5 SL >2.0 L&C	>1.0 S >1.5 SL >2.0 L&C	>1.0 S >1.5 SL >2.0 L&C	>1.0 S >1.5 SL >2.0 L&C
Salinity EC_c	ds/m	<4	<2	<2	<2	<2	<2
Nitrate – N	mg/kg	Na	20 – 50	20 – 50	20 – 50	50	20 - 50
Exch Ca	mg/kg	600 – 1200	900 – 1200	1200 - 1500	1500	1500	1200
Exch Mg	mg/kg	100 – 200*	150 – 200	200 – 250	200 – 250	250	200
Exch Na	%	<6 – 15	<6	<6	<6	<6	<6
Exch K	%	3 – 8%	3 – 8%				
Exch Al	%	<5%	<5%	<5%	<5%	<5%	<5%
CEC	meq	6 – 15	8 – 15	8 – 15	8 – 15	10 – 20	6 – 15
Ca:Mg Ratio	meq	3.5:1* 2 –8:1 non GT soil	3 – 6:1	3 – 6:1	4 – 5:1	3 – 5:1	3 – 6:1
K/(Ca+Mg)	meq	<.08	<.07			<.07	
K:Mg	meq	<1.5	<1.0	<0.5	<0.5	<0.5	<1.0
Ext Cu**	mg/kg	0.5 – 1.0? sands lower	1?	2 – 4?	2 – 4?	4 – 5?	2 – 4?
Ext Zn**	mg/kg	0.7 – 1.2?	1.2 – 2.0?	4?	4?	5 – 6?	4?
Ext Mn**	mg/kg	5 – 10+?	10 – 20+?	10 – 20+?	20+?	20 – 30+?	20+?
Ext Fe**	mg/kg	Na	na	Na	Na	Na	na
Ext Al	mg/kg	<4	<4	<4	<4	<4	<4
Ext B	mg/kg	0.5 – 1.0+	0.5 – 1.0+	>1.0+	>1.0+	>1.5+	>1.0+
Cl	mg/kg	<120 S - SL <180 L - CL <300 C	<120 S – SL <180 L – CL <300 C	<120 S – SL <180 L - CL <300 C	120 S – SL <180 L - CL <300 C	120 S – SL <180 L - CL <300 C	120 S – SL <180 L - CL <300 C

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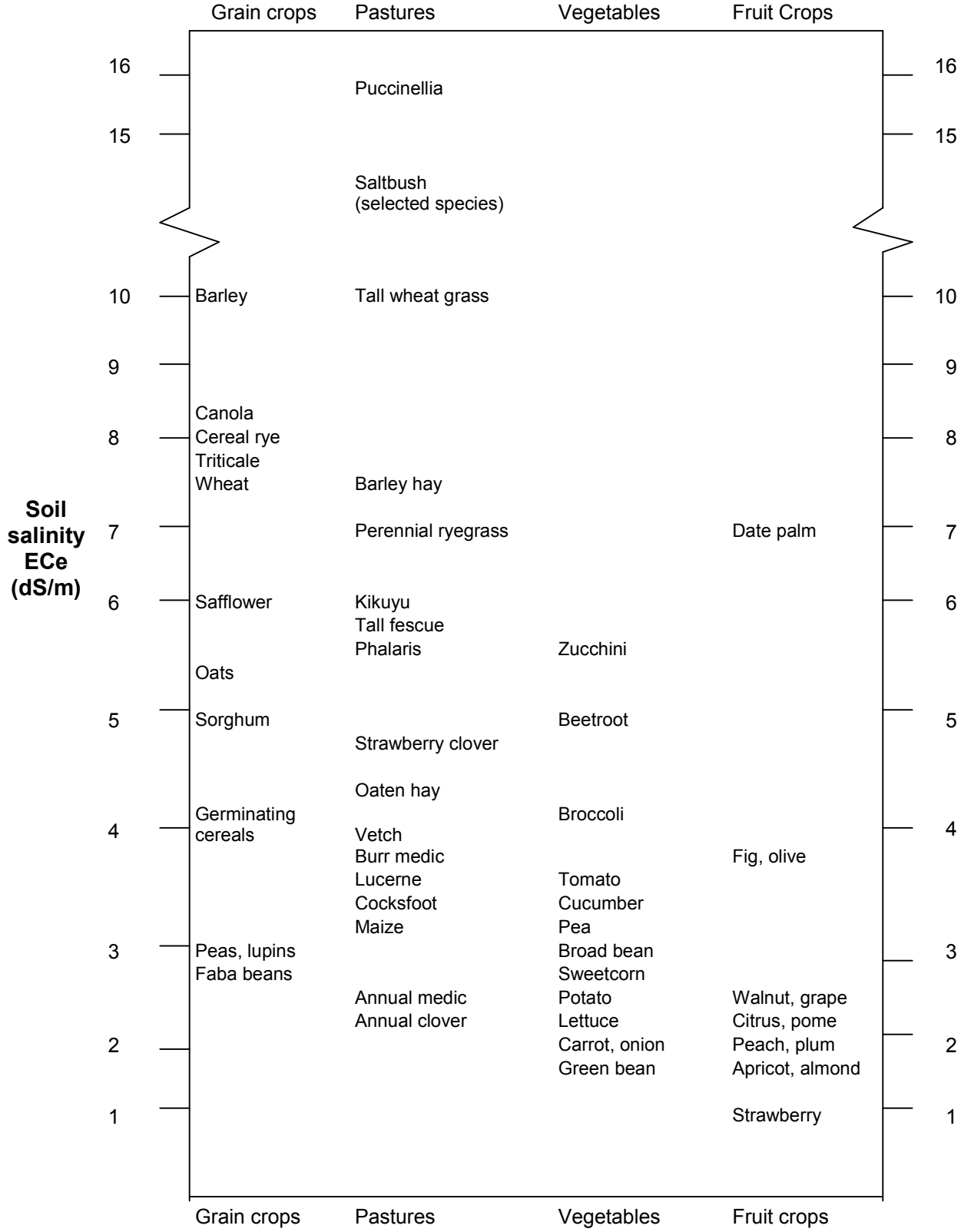
Relative tolerance of plants to soil salinity



HOW TO USE THIS CHART

Use the "ECe (est.)" figure from the results sheet, not the "EC (1:5)" figure. In the chart, plant names are positioned at the soil salinity figure which will cause a 10% yield reduction. Compare your soil test with the figure indicated for a particular plant. Higher soil salinities than those shown will cause greater yield losses for that plant.

Germinating plants will suffer more from salt than indicated by this chart. Waterlogging will also increase salinity effects. Relative salt tolerances are approximate and are based on limited information. For further advice, contact your local Primary Industries SA office.

References: Ayers (1977), Mass and Hoffman (1977), VIRASC (1969) and Shaw *etal* (1987). Compiled by T Hermann and A Solomon, Primary Industries SA, December 1994.