Useful conversions and relationships

EC_{1:5} and chloride_{1:5} conversions

To estimate the contribution of chloride to $EC_{1:5}$ in a 1:5 soil:water suspension, assuming chloride is the dominant ion, where EC_{Cl} is measured as dS/m:

A more accurate measure of the contribution of chloride to $EC_{1:5}$ (Shaw 1994) is given by:

 $\log EC_{Cl} = 0.92 \log(56.42 \times \% Cl) - 0.865 \dots 39$

Percentage chloride can be determined from other measures of chloride contribution as follows:

%Cl =	(<i>mgCl</i> / kg soil)* 10 ⁻⁴ 40
%CI=	mmole _c CL/100g soil
/JCT -	28.21
%(1-	mmole _c CL/litre of soil extract
/001-	56.42

SAR and ESP conversions

To convert the SAR of a soil solution or irrigation water to the expected soil ESP in equilibrium with that water (USSL 1954):

This empirical equation satisfies the theoretical boundary condition for high SAR and ESP values. However, the original data used in the derivation of this relationship were SAR < 65 and ESP < 50.

The reverse regressed relationship for the USSL (1954) data, which should not be applied for ESP > 50, is:

 $(R_2 = 0.888)$

The 95% confidence limits on the coefficients are:

a 0.340–1.041

b 0.986-1.270.

Common salts and ions: converting from mg/L to mmole_c/L (meq/L)

To convert from mg/L to mmole _c /L	divide by (equivalent weight)
lons	
Ca ²⁺	20.0
K+	39.1
Mg ²⁺	12.2
Na ⁺	23.0
Cl⁻	35.5
CO ₃ ²⁻	30.0
HCO ₃ ²⁻	61.0
NO ₃ ⁻	62.0
S0 ₄ ²⁻	48.0
Salts	
CaCO ₃	50.0
CaSO ₄	68.1
NaCl	58.5
Na ₂ CO ₃	53.0
NaHCO ₃	84.0

Note: $mmole_c/L$ and meq/L are identical units. $mmole_c/L$ is consistent with the SI unit convention. The subscript 'c' refers to unit charge and accounts for differences caused by ion valency.

Converting units of concentration

To convert from	to	multiply by
grains/gallon (imperial)	mg/L	14.25
grains/gallon NaCl	mg Cl/L	8.66
parts/100 000	mg/L	10
normality	mmole _c /L	1 000
meq/L	mmole _c /L	1
mmole _c /L	meq/L	1
mmole _c /L	mg/L	equivalent weight (table above)
mmole _c /L	mmole/L	valency
mg/L	tons of salt per acre foot	0.00136
mg/L	tonnes of salt per ML (where	1.001
	1 ML = 1	
	hectare x 100	
	mm depth)	

Converting between EC units and approximate TDI values

lf you			multiply	nultiply by the numbers shown in the table to get these units					
have these units	S/m	dS/m	mS/m	μ S/m	mS/cm	μ S/cm	TDI mg/L (ppm)	mmolec/L (meq/L)	grains/ gallon
S/m		10	1 000	1 000 000	10	10 000	2/3 x 10 000	100	400
dS/m	0.1		100	100 000	1	1 000	2/3 x 1 000	10	40
mS/m	0.001	0.01		1 000	0.01	10	2/3 x 10	0.1	0.4
μS/m	10 ⁻⁶	10 ⁻⁵	0.001		10 ⁻⁵	0.01	2/3 x 0.01	10 ⁻⁴	4 000
mS/cm	0.1	1	100	100 000		1 000	2/3 x 1 000	10	40
µS/cm	10 ⁻⁴	0.001	0.1	100	0.001		2/3	0.01	0.04
TDI mg/L (ppm)	1.5 X 10 ⁻⁴	0.0015	0.15	150	0.0015	1.5		0.015	0.06
mmole _c /L (meq/L)	0.01	0.1	10	10 000	0.1	100	2/3 x 100		4
grains/ gallon (imperial)	0.002	0.02	2	2 000	0.02	20	14	0.02	

Note: TDI conversions are working approximations only, suitable for quick calculations. More accurate methods for TDI conversions are provided in the table Converting from electrical conductivity (EC dS/m) to other measures of salinity page 159.

Converting from electrical conductivity EC (dS/m) to other measures of salinity

To convert EC (dS/m) to	in the EC (dS/m) range	multiply by/calculate	Reference
TDS mg/L1	0.1 to 5	640	USSL (1954)
(strictly Total Dissolved Salts by concentration; approximates TDI)			
	0.2 to 0.6	620–740	
	o.6 to 6	600	VIRASC (1980)
	6 to 30	600–690	
TDS (calculated) mg/L1	< 2.4	550-950	Tanji & Biggar (1972)
(equivalent to TDI)		730–780 (average)	
mmolec/L (meq/L)2		approx. 10	USSL (1954)
		9.1–13.1	Tanji & Biggar (1972)
		log N = 0.955 + 1.039(log EC)	Marion & Babcock (1976)
		where N is equivalent concetration	
		(note following table for reverse calculations)	
Osmotic potential (bars)		log osmotic potential = 1.111	McIntyre (1980)
		(log EC) – 0.512	
% total soluble salts		0.336	
(for 1:5 soil:water suspension)			

Notes:

1. For definitions of TDI, TDS (calculated) and TDS (evaporation), refer to glossary entry for salinity.

2. Undissociated ions and ion pair formation result in proportionately lower EC with increasing concentration.

Converting from equivalent concentration (mmole,/L) to EC (dS/m)

To convert equivalent concentration (mmole _c /L) to	calculate	Reference
EC (dS/m)	where N is equivalent concentration (mmole _c /L):	
	log EC = 0.960(log N) - 0.917	reverse of Marion & Babcock (1976) equation
	log EC = 0.921(log N) – 0.865	McIntyre (1980)

Converting measures of soil volume and density

Void ratio = $\frac{\text{volume of pores}}{\text{volume of solids}}$

soil particle density -------------------------+1

bulk density

 $\frac{2650}{\text{bulk density (kg/m^3)}} + 1$

Soil porosity = $1 - \frac{\text{bulk density}}{\text{soil particle density}}$

1 000 (1 – air content as %) Soil porosity = 1 - -1 0 0 0 + water content soil particle density (kg/kg)(kg/m³)

For cracking clay soils and 5% air content at macimum field water content

Bulk desnity at $W_{max}(kg/m^3) = \frac{950}{0.3774 + W_{max}(kg/kg)}$

Figure 74. Schematic diagram of the soil as a three-phase system. M and V denote mass and volume while subscripts s, w, a, t and p refer to soil solids, water, air, total soil and porosity respectively (from Gardner 1985).



Notes on gypsum

- Fertiliser-grade gypsum is about 90% pure and contains 23% of calcium by weight.
- One mmolec/L of Ca from 100% gypsum = 86 kg gypsum dissolved in 1-000 m³ of water, (that is, per ML).
- To replace exchangeable Na on soil clay exchange sites with Ca from gypsum (assuming full efficiency of exchange in Na replacement): for each cmole_c/ kg of exchangeable Na (cmole_/kg soil) in soil per hectare of 100 mm depth, use 1.375 tonnes of 100% pure gypsum.

For example, to reduce ESP from 6 to 3 in the surface 100 mm of a soil would require 3 x 1.375 tonnes of gypsum at 100% pure or 3 x 1.375/0.9 at 90% pure. Since it will not be fully utilised in ion exchange, the amount of gypsum should be increased by approximately 1.5 for the soil surface and more for greater depths. A reasonable application per hectare of soil surface is 3 to 5 tonnes.

Figure 75. Soil is composed of solid particles of many different shapes and sizes interspersed with pore space containing varying mixtures of soil solution and air (Gardner 1985).

