ABCs for Interpreting EAL Agricultural Soil Test Reports

The concept of 'general guidelines' is based on soil type (heavy, medium, light, sandy) whereby the type is determined by texture and Effective Cation Exchange Capacity (ECEC). This is based on the Basic Cation Saturation Ratio (BCSR) concept.

A Determine appropriate soil type guideline

- Choose appropriate guidelines based on your soil's Effective Cation Exchange Capacity and soil type (i.e. 10.33 ECEC and clay loam description in example soil).
- Using this guideline, interpret the soil's comparable levels of exchangeable calcium, magnesium, potassium and sodium (i.e. deficiency or excess).

B Compare each macro and micro nutrient to guidelines

- Check soil pH; if pH < 5 then the acidity has the potential to cause various soil fertility issues. The addition of lime will typically correct issues with calcium deficiency and pH.
- Check Bray 1 phosphorus levels for acid soils and Colwell phosphorus for alkaline soils (pH > 7).
- Check each soluble nutrient, then assess total nutrients, to identify STORES of nutrients bound-up in the soil.

C Calculate deficiencies and determine fertiliser/compost requirements

- Calculate the difference between each nutrient. The guideline in mg/kg gives the nutrient requirement. In the example soil test – for calcium the difference is 2 150 – 1 193 mg/kg = 957 mg calcium/kg soil.

  Refer to the conversion information below:

  - To get 1 kg/ha use 2.24 x mg/kg (i.e. 2.24 x 957 = 2 144 kg/ha calcium required)
  - Determine lime kg/ha application rate using 'Example 2' attached – lime is approximately 40% calcium
  - kg lime/ha = 2 144 x 100/40 = 5360 kg/ha = 5.36 tonnes lime/ha.

  Note: 5.4 tonnes lime/ha is very high and not typically recommended (max typical application rate is 2 tonnes/ha). Gypsum can also be used in conjunction with lime for calcium.

- Repeat for each deficient nutrient noting that agronomists typically use computer programs to automate the fertiliser application rate calculation.
- Applying compost with added fertiliser is one way of increasing organic matter while holding nutrients in the soil.

Refer to the colour-coded example of a routine Agricultural Soil Test Report for further instructions.

Southern Cross University
ABN: 41 995 651 524

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Environmental Analysis Laboratory
Southern Cross University

Southern Cross University
PO Box 157 Lismore NSW 2480

T: (02) 6620 3678
F: (02) 6620 3957
E: eal@scu.edu.au
W: scu.edu.au/eal
ABN: 41 995 651 524

ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

Job No:	
No of Samples:	
Date Supplied:	
Supplied by:	

					Sample 1	***Heavy Soil***	***Medium Soil***	***Light Soil***	***Sandy Soil***
				Sample ID:	Pdk 1				
				Crop:	Oats				
				Client:	EAL	*e.g Clay*	*e.g Clay Loam*	*e.g Loam*	*e.g Loamy Sand*
	Method	*Nutrient*		*Units*	*XXXXX/1*	***Indicative guidelines only- refer Note 6***			
	Morgan 1	Calcium	Ca	mg/kg	694	*1150*	*750*	*375*	*175*
		Magnesium	Mg		164	*160*	*105*	*60*	*25*
		Potassium	K		425	*113*	*75*	*60*	*50*
		Phosphorus	P		4.0	*15*	*12*	*10*	*5.0*
	Bray1	Phosphorus	P	mg/kg	14	*45[note 8]*	*30[note 8]*	*24[note 8]*	*20[note 8]*
	Colwell				24	*80*	*50*	*45*	*35*
	Bray2				21	*90[note 8]*	*60[note 8]*	*48[note 8]*	*40[note 8]*
	KCl	Nitrate Nitrogen	N	mg/kg	14.5	*15*	*13*	*10*	*10*
		Ammonium Nitrogen			11.9	*20*	*18*	*15*	*12*
		Sulfur	S		0.2	*10.0*	*8.0*	*8.0*	*7.0*
	1:5 Water	pH		units	6.92	*6.5*	*6.5*	*6.3*	*6.3*
		Conductivity		dS/m	0.069	*0.200*	*0.150*	*0.120*	*0.100*
	Calculation	Estimated Organic Matter		% OM	1.5	*>5.5*	*>4.5*	*>3.5*	*>2.5*
	Ammonium Acetate + Calculations	Calcium	Ca	$cmol^+/Kg$	5.95	*15.6*	*10.8*	*5.0*	*1.9*
				kg/ha	2673	*6250*	*4300*	*2000*	*750*
				mg/kg	1193	*3125*	*2150*	*1000*	*375*
		Magnesium	Mg	$cmol^+/Kg$	1.99	*2.4*	*1.7*	*1.2*	*0.60*
				kg/ha	541	*580*	*400*	*290*	*150*
				mg/kg	241	*290*	*200*	*145*	*75*
		Potassium	K	$cmol^+/Kg$	2.31	*0.60*	*0.50*	*0.40*	*0.30*
				kg/ha	2023	*470*	*380*	*300*	*200*
				mg/kg	903	*235*	*190*	*150*	*100*
		Sodium	Na	$cmol^+/Kg$	0.07	*0.3*	*0.26*	*0.22*	*0.11*
				kg/ha	36	*138*	*120*	*101*	*51*
				mg/kg	16	*69*	*60*	*51*	*25*
	KCl	Aluminium	Al	$cmol^+/Kg$	0.01	*0.6*	*5*	*0.5*	*0.2*
				kg/ha	3	*108*	*90*	*81*	*27*
				mg/kg	1	*54*	*45*	*41*	*14*
	Acidity Titration	Hydrogen	H^+	$cmol^+/Kg$	0.00	*0.6*	*5*	*0.5*	*0.2*
				kg/ha	0	*12*	*10*	*9*	*3*
				mg/kg	0	*6*	*5*	*5*	*2*
	Calculation	Effective Cation Exchange Capacity (ECEC)		$cmol^+/Kg$	10.3	*20*	*14*	*7*	*4*
	Base Saturation Calculations	Calcium	Ca	%	57.6	*77*	*76*	*69*	*60*
		Magnesium	Mg		19.2	*12*	*12*	*16*	*20*
		Potassium	K		22.4	*3*	*4*	*5*	*8*
		Sodium - ESP	Na		0.7	*2*	*2*	*3*	*3*
		Aluminium	Al		0.1	*7*	*7*	*7*	*9*
		Hydrogen	H^+		0.0				
	Calculation	Calcium / Magnesium Ratio		ratio	3.0	*6.4*	*6.3*	*4.3*	*3.0*
	DTPA	Zinc	Zn	mg/kg	0.9	*6.0*	*5.0*	*4.0*	*3.0*
		Manganese	Mn		20	*25*	*22*	*18*	*15*
		Iron	Fe		26	*25*	*22*	*18*	*15*
		Copper	Cu		1.1	*2.4*	*2.0*	*1.6*	*1.2*
	$CaCl_2$	Boron	B	mg/kg	1.00	*2.0*	*1.7*	*1.4*	*1.0*
		Silicon	Si		58	*50*	*45*	*40*	*35*
	LECO IR Analyser	Total Carbon	C	%	0.84	*>3.1*	*>2.6*	*>2.0*	*>1.4*
		Total Nitrogen	N	%	0.10	*>0.30*	*>0.25*	*>0.20*	*>0.15*
	Calculation	Carbon/ Nitrogen Ratio		ratio	8.4	*10-12*	*10-12*	*10-12*	*10-12*
		Basic Texture			Clay Loam	..	..	..	..
		Basic Colour			Red	..	..	..	..
	Calculation	Chloride Estimate		equiv. ppm	44	..	..	..	..

Environmental Analysis Laboratory
Southern Cross University

Southern Cross University
PO Box 157 Lismore NSW 2480

T: (02) 6620 3678
F: (02) 6620 3957
E: eal@scu.edu.au
W: scu.edu.au/eal
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	Sample 1	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
Sample ID:	Pdk 1				
Crop:	Oats				
Client:	EAL	*e.g Clay*	*e.g Clay Loam*	*e.g Loam*	*e.g Loamy Sand*

Method	*Nutrient*		*Units*	*XXXXX/1*	***Indicative guidelines only- refer Note 6***
Total Acid Extractable	Calcium	Ca	mg/kg	1,396	*1,000 - 10,000 Ca*
	Magnesium	Mg		1,200	*500 - 5,000 Mg*
	Potassium	K		2,941	*200 - 2,000 K*
	Sodium	Na		<50	*100 - 500 Na*
	Sulfur	S		53	*100 - 1,000 S*
Total Acid Extractable	Phosphorus	P	mg/kg	216	*400 - 1,500 P*
Total Acid Extractable	Zinc	Zn	mg/kg	18	*20 - 50 Zn*
	Manganese	Mn		216	*200 - 2,000 Mn*
	Iron	Fe		14,585	*1,000 - 50,000 Fe*
	Copper	Cu		11.2	*20 - 50 Cu*
	Boron	B		3	*2 - 50 B*
	Silicon	Si		1,038	*1,000 - 3,000 Si*
	Aluminium	Al		10,308	*2,000 - 50,000 Al*
Total Acid Extractable	Molybdenum	Mo	mg/kg	0.2	*0.5 - 3 Mo*
	Cobalt	Co		5	*5 - 50 Co*
	Selenium	Se		<0.5	*0.1 - 2.0 Se*
Total Acid Extractable	Cadmium	Cd	mg/kg	<0.5	*< 5 Cd*
	Lead	Pb		12	*< 75 Pb*
	Arsenic	As		495	*< 25 As*
	Chromium	Cr		19	*<25 Cr*
	Nickel	Ni		18	*<150 Ni*
	Mercury	Hg		0.2	*< 3.75 Hg*
	Silver	Ag		<1	*.. Ag*

EAL Soil Testing Notes

1. All results presented as a 40°C oven dried weight. Soil sieved and lightly crushed to <2 mm
2. Methods from Rayment and Lyons, 2011. *Soil Chemical Methods*
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH
4. 'Morgan 1 Extract' adapted from 'Science in Agriculture', 'Non-Toxic Farming' and Lamonte Soil Handbook.
5. Guidelines for phosphorus have been reduced for Australian soils
6. Indicative guidelines are based on 'Albrecht' and 'Reams' concepts
7. Total Acid Extractable Nutrients indicate a store of nutrients
8. Contaminant Guides based on 'Residential with gardens and accessible soil including childrens daycare centres, preschools, primary schools, town houses or villas' (NSW EPA 1998).
9. Information relating to testing colour codes is available on Sheet 2 - "*Understanding you soil results*"

Calculations

1. For conductivity 1 dS/m = 1 mS/cm = 1000 µS/cm
2. 1 $cmol^+$/Kg = 1 meq/100g; 1 Lb/Acre = 2 ppm (parts per million); kg/ha = 2.24 x ppm; mg/kg = ppm
3. Conversions for 1 cmol+/Kg = 230 mg/Kg Sodium, 390 mg/Kg Potassium, 122 mg/Kg Magnesium, 200 mg/Kg Calcium
4. Organic Matter = %C x 1.75
5. Chloride Estimate = EC x 640 (most likely over-estimate)
6. ECEC = sum of the exchangeable cations $cmol^+$/Kg
7. Base saturation calculations = (cation cmol+/Kg) /ECEC x 100
8. Ca / Mg ratio from the exchangeable $cmol^+$/Kg results

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ABN: 41 995 651 524

Understanding your EAL soil results

Soil Acidity - Is the water pH >6.5 or $CaCl_2$ pH >5.5 – hence no major problem. >7pH indicates alkaline soil. Soil with pH below 4.5 often has high kg/ha exchangeable hydrogen and aluminium (and likely high % exchangeable H and Al).

Cation Exchange Capacity - Using the ECEC or CEC is the soil heavy, medium, light or sandy? In particular, compare the exchangeable Calcium and Potassium in kg/ha to suggested guidelines.

Soil Salinity - Is the electrical conductivity (EC) above texture guidelines (ie. > 0.2dS/m heavy soil) – hence indicates possible salinity issue. If the Exchangeable Sodium Percentage or % Exchangeable Sodium > 5% then possible salt issue. With high EC the chloride is also likely to be elevated.

Ca/Mg Ratio - Above 5 indicates good soil structure. Ratio 1 – 5 suggests addition of calcium to assist soil structure. Ratio <1 (ie. far higher magnesium) often indicates high clay soil and possibly a sub-soil. Compaction and poor water infiltration is a likely indication of the cation imbalance.

Organic Matter - Refer to guidelines - >5.5% indicates good organic carbon and organic matter in the soil. Total Carbon to Total Nitrogen ratio should be around 12:1 – If higher then suggests depletion of organic nitrogen.

Phosphorus - Are the levels of Bray I (plant available)/Bray II (exchangeable P) below or above the guidelines. At, above or near guidelines suggests no need for P addition.

Solubles - Nitrate, ammonium and sulfur – compare to guidelines for soil type. Leachable nutrients hence may be further down soil profile.

Micronutrients - Plant available Iron, Manganese, Copper and Zinc – compare to guidelines to assess if relatively low or high. Iron and manganese availability is significantly influenced by soil pH (acid soils often have very high soluble iron). Leaf testing is ideal for confirming potential issues with micronutrients.

Boron - A micronutrient extracted as plant available – compare to guidelines but be aware boron is very leachable and could be elevated down the soil profile.

Acid Extractable Nutrients - If total available nutrients were analysed then use numbers as a guide to compare to assess store of nutrients.