Interpreting EAL Agricultural Soil Reports

Environmental Analysis Laboratory

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.

DETERMINE THE APPROPRIATE SOIL TYPE GUIDELINE FOR BASIC ASSESSMENT

- Choose the appropriate guideline based on your soil's Effective Cation Exchange Capacity (ECEC) and texture. In the example, an ECEC of 10.3 and basic texture of clay loam equates to a medium soil type.
- Compare exchangeable calcium, magnesium, potassium and sodium results to the appropriate guideline to determine whether the elements are deficient or in excess. In the example, exchangeable calcium and sodium are deficient while magnesium and potassium are in excess. This information may be sufficient for your needs without reference to the following steps.

ASSESS THE SOLUBLE AND TOTAL STORES OF MACRO AND MICRO NUTRIENTS IN THE SOIL

- Check whether the soil pH < 5; acidity can cause various soil fertility issues. The example soil has a neutral pH (6.92).
- Compare the phosphorous results against the Bray 1 guideline for acid soils and against the Colwell phosphorous for alkaline soils (> pH 7). The example soil is deficient in available phosphorous.
- Compare the Morgan 1 extract results for soluble nutrients to the guideline, then assess these against the total acid extractable nutrients, to identify stores of nutrients bound-up in the soil. The example soil is deficient in soluble calcium and phosphorous. While there is a store of calcium in the soil, total phosphorous levels are less than the indicative guidelines.

CALCULATE DEFICIENCIES AND DETERMINE SOIL AMENDMENT REQUIREMENTS

- Calculate the difference between exchangeable nutrient results and the guideline. For the example soil the guideline is 2150 mg calcium/kg, while the test result is 1193 mg calcium/kg. The difference (guideline value – test result) of 957 mg calcium/kg soil indicates a deficiency that could benefit from soil amendments.

  The following calculations may assist:

  - To convert mg/kg to kg/ha use the formula 2.24 x mg/kg deficiency. For the example soil the deficiency is 2.24 x 957 mg calcium/kg = 2144 kg calcium/ha.
  - To convert kg calcium/ha to kg lime/ha, assuming lime is 40% calcium, use the formula mg calcium/kg x 100/40. For the example soil 2144 x 100/40 = 5360 kg lime/ha = 5.36 t lime/ha.

Note: 5.4 t lime/ha is very high and not usually recommended – the maximum application rate is usually 2 t/ha. Gypsum can also be used in conjunction with lime to increase soil calcium.

- Repeat this process for each deficient nutrient. Note: agronomists usually use computer programs to automate fertiliser application rate calculations.
- Applications of compost with added fertiliser is one way to increase organic matter and the capacity of the soil to hold nutrients.

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

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Understanding your EAL agricultural soil results

An EAL agricultural soil test report holds a wealth of information. To assist in its interpretation, please refer to the colour coded text below and within the report. For example, phosphorous results can be quickly located by looking for the yellow bar to the left of the data. The Parameter column of the report defines the test undertaken, while the Method reference indicates which technique was used. To the right of your data, indicative guidelines have been provided based on soil texture. In the phosphorous example, Bray I data would be used to assess plant available results, while Bray II would give exchangeable information.

Ammonium acetate	**Effective Cation Exchange Capacity** - The ECEC result can be related to the texture of the soil (heavy, medium, light or sandy). Comparing results to indicative values can give you an idea of the soil texture. Knowing the soil texture can guide your interpretation of other parameters against the guidelines. Exchangeable elements give you an idea of the available nutrients. In particular, compare exchangeable calcium and potassium (kg/ha) to the indicative guidelines.
pH	**Soil pH** - A water pH > 6.5 or $CaCl_2$ pH > 5.5 indicates no major problem. Soils with pH > 7 are considered alkaline. Soils with pH < 4.5 often have high exchangeable hydrogen and aluminium (kg/ha; with high % hydrogen and aluminium base saturation). Acidic soils often have aluminium toxicities.
Conductivity, Chloride Estimate	**Soil Salinity** - An electrical conductivity (EC) greater than the texture guidelines (e.g. > 0.2 dS/m heavy soil) may indicate a salinity issue. If the Exchangeable Sodium Percentage (ESP) or % Exchangeable Sodium is > 5% you may have a salt issue. High EC soils can have elevated chloride concentrations.
Calcium/Magnesium Ratio	**Calcium/Magnesium Ratio** - A Ca/Mg ratio of 5 indicates good soil structure. The structure of a soil with a ratio of 1–5 may benefit from additional calcium. A ratio < 1 (significantly more Mg than Ca) often indicates high clay content soil and possibly a clay sub-soil. The cation imbalance may be due to compaction and poor water infiltration.
Estimated organic matter	**Organic Matter** - An organic matter content greater than the indicative guidelines for the appropriate soil type indicates good organic carbon levels. For example OM > 4.5% in a medium soil. The Carbon/Nitrogen ratio should be between 10 and 12. Higher values suggest a depletion in organic nitrogen.
Bray, Colwell and Olsen	**Phosphorus** - For acidic soils Bray I phosphorous indicates plant available results. Bray II provides the available and some exchangeable phosphorous. For neutral to alkaline soils Colwell P provides the extractable and Olsen P the readily available phosphourous.
Morgan 1 and KCl	**Solubles** - Nitrate, ammonium and sulfur are leachable nutrients and may accumulate down the soil profile. Indicative values are given relative to soil texture.
DTPA	**Micronutrients** - Plant available iron, manganese, copper and zinc should be compared to indicative guidelines to assess whether levels are 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 micronutrient concentrations.
$CaCl_2$	**Boron** - The $CaCl_2$ extracted boron is the plant available form of the micronutrient. Boron is very leachable and can accumulate down the soil profile.
PBI	**Phosphorus Buffer Index (PBI; no units)** - Soils with higher PBI values up to 1000 have a greater capacity to absorb phosphorous. Therefore, low PBI soils have limited ability to tie up phosphourous ammendments.
Total Acid Extractable	**Acid Extractable Nutrients** - Total available nutrient concentrations give an indication of the store of nutrients in the soil.

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ROUTINE AGRICULTURAL SOIL ANALYSIS REPORT

1 sample supplied by Client Company on the 6th of April, 2018 - Lab. Job No. XXXX.
Analysis requested by Valued Client.
(1 Soil Avenue, ROCKWELL NSW 1111)

	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*

Parameter	Method reference	XXXX/1	Indicative guidelines only - refer to Notes 6 and 8			
Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	694	*1150*	*750*	*375*	*175*
Soluble Magnesium (mg/kg)		164	*160*	*105*	*60*	*25*
Soluble Potassium (mg/kg)		425	*113*	*75*	*60*	*50*
Soluble Phosphorus (mg/kg)		4.0	*15*	*12*	*10*	*5.0*
Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	14	*45 note 8*	*30 note 8*	*24 note 8*	*20 note 8*
	**Rayment & Lyons 2011 - 9B2 (Colwell)	24	*80*	*50*	*45*	*35*
	**Inhouse S3A (Bray 2)	21	*90 note 8*	*60 note 8*	*48 note 8*	*40 note 8*
Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	14.5	*15*	*13*	*10*	*10*
Ammonium Nitrogen (mg/kg N)		11.9	*20*	*18*	*15*	*12*
Sulfur (mg/kg S)		0.2	*10.0*	*8.0*	*8.0*	*7.0*
pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.92	*6.5*	*6.5*	*6.3*	*6.3*
Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.069	*0.200*	*0.150*	*0.120*	*0.100*
Estimated Organic Matter (% OM)	**Calculation - Total Carbon x 1.75	1.5	*> 5.5*	*> 4.5*	*> 3.5*	*> 2.5*
Exchangeable Calcium (cmol$_+$/kg)	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	5.95	*15.6*	*10.8*	*5.0*	*1.9*
Exchangeable Calcium (kg/ha)		2673	*7000*	*4816*	*2240*	*840*
Exchangeable Calcium (mg/kg)		1193	*3125*	*2150*	*1000*	*375*
Exchangeable Magnesium (cmol$_+$/kg)		1.99	*2.4*	*1.7*	*1.2*	*0.60*
Exchangeable Magnesium (kg/ha)		541	*650*	*448*	*325*	*168*
Exchangeable Magnesium (mg/kg)		241	*290*	*200*	*145*	*75*
Exchangeable Potassium (cmol$_+$/kg)		2.31	*0.60*	*0.50*	*0.40*	*0.30*
Exchangeable Potassium (kg/ha)		2023	*526*	*426*	*336*	*224*
Exchangeable Potassium (mg/kg)		903	*235*	*190*	*150*	*100*
Exchangeable Sodium (cmol$_+$/kg)		0.07	*0.3*	*0.26*	*0.22*	*0.11*
Exchangeable Sodium (kg/ha)		36	*155*	*134*	*113*	*57*
Exchangeable Sodium (mg/kg)		16	*69*	*60*	*51*	*25*
Exchangeable Aluminium (cmol$_+$/kg)	**Inhouse S37 (KCl)	0.01	*0.6*	*0.5*	*0.4*	*0.2*
Exchangeable Aluminium (kg/ha)		3	*121*	*101*	*73*	*30*
Exchangeable Aluminium (mg/kg)		1	*54*	*45*	*32*	*14*
Exchangeable Hydrogen (cmol$_+$/kg)	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.00	*0.6*	*0.5*	*0.4*	*0.2*
Exchangeable Hydrogen (kg/ha)		0	*13*	*11*	*8*	*3*
Exchangeable Hydrogen (mg/kg)		0	*6*	*5*	*4*	*2*
Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)	**Calculation - Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	10.3	*20.1*	*14.3*	*7.8*	*3.3*
Calcium (%)	**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	57.6	*77.6*	*75.7*	*65.6*	*57.4*
Magnesium (%)		19.2	*11.9*	*11.9*	*15.7*	*18.1*
Potassium (%)		22.4	*3.0*	*3.5*	*5.2*	*9.1*
Sodium - ESP (%)		0.7	*1.5*	*1.8*	*2.9*	*3.3*
Aluminium (%)		0.1	*6.0*	*7.1*	*10.5*	*12.1*
Hydrogen		0.0				
Calcium/Magnesium Ratio	**Calculation - Calcium / Magnesium (cmol$_+$/kg)	3.0	*6.5*	*6.4*	*4.2*	*3.2*

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	Crop:	Pdk 1				
	Client:	Oats	e.g. Clay	e.g. Clay Loam	e.g. Loam	e.g. Loamy Sand
Parameter	Method reference	XXXX/1	Indicative guidelines only - refer to Notes 6 and 8			
Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	0.9	6.0	5.0	4.0	3.0
Manganese (mg/kg)		20	25	22	18	15
Iron (mg/kg)		26	25	22	18	15
Copper (mg/kg)		1.1	2.4	2.0	1.6	1.2
Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	1.00	2.0	1.7	1.4	1.0
Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	58	50	45	40	35
Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	0.84	> 3.1	> 2.6	> 2.0	> 1.4
Total Nitrogen (%)		0.10	> 0.30	> 0.25	> 0.20	> 0.15
Carbon/Nitrogen Ratio	**Calculation - Total Carbon/Total Nitrogen	8.4	10–12	10–12	10–12	10–12
Basic Texture	**Inhouse	Clay Loam	..	..	..	..
Basic Colour		Red	..	..	..	..
Chloride Estimate (equiv. ppm)	**Calculation - Electrical Conductivity x 640	44	..	..	..	..
Total Calcium (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia	1,396	1000–10 000 Ca			
Total Magnesium (mg/kg)		1,200	500–5000 Mg			
Total Potassium (mg/kg)		2,941	200–2000 K			
Total Sodium (mg/kg)		<50	100–500 Na			
Total Sulfur (mg/kg)		53	100–1000 S			
Total Phosphorus (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia	216	400–1500 P			
Total Zinc (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia	18	20–50 Zn			
Total Manganese (mg/kg)		216	200–2000 Mn			
Total Iron (mg/kg)		14,585	1000–50 000 Fe			
Total Copper (mg/kg)		11.2	20–50 Cu			
Total Boron (mg/kg)		3	2–50 B			
Total Silicon (mg/kg)		1,038	1000–3000 Si			
Total Aluminium (mg/kg)		10,308	2000–50 000 Al			
Total Molybdenum (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia	0.2	0.5–3.0 Mo			
Total Cobalt (mg/kg)		5	5–50 Co			
Total Selenium (mg/kg)		< 0.5	0.1–2.0 Se			
Total Cadmium (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia	< 0.5	<1 Cd			
Total Lead (mg/kg)		12	2–200 Pb			
Total Arsenic (mg/kg)		495	1–50 As			
Total Chromium (mg/kg)		19	5–1000 Cr			
Total Nickel (mg/kg)		18	5–500 Ni			
Total Mercury (mg/kg)		0.2	< 0.2 Hg			
Total Silver (mg/kg)		< 1	.. Ag			
Phosphorus Buffer Index	**Rayment & Lyons 2011 - 9I4b (PBI)	226	<15 extremely Low; 141–280 Moderate;	15–70 Very Low; 280–840 High;	71–140 Low; > 840 Very High	

Method notes can be found on the following page.

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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 - Australasia.* CSIRO Publishing: Collingwood.
3. Soluble Salts included in Exchangeable Cations - NO PRE-WASH (unless requested).
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. National Environmental Protection (Assessment of Site Contamination) Measure 2013, Schedule B(1) - Guideline on Investigation Levels for Soil and Groundwater. Table 5-A Background Ranges.
9. Information relating to testing colour codes is available on sheet 2 - 'Understanding your agricultural soil results'.
10. Conversions for 1 $cmol_+/kg$ = 230 mg/kg Sodium, 390 mg/kg Potassium, 122 mg/kg Magnesium, 200 mg/kg Calcium
11. ** NATA accreditation does not cover the performance of this service.
12. Analysis conducted between sample arrival date and reporting date.
13. This report is not to be reproduced except in full.

Quality Checked: Kris Saville
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