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EAL Environmental Analysis Laboratory

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What Your Soil & Leaves are Telling You!

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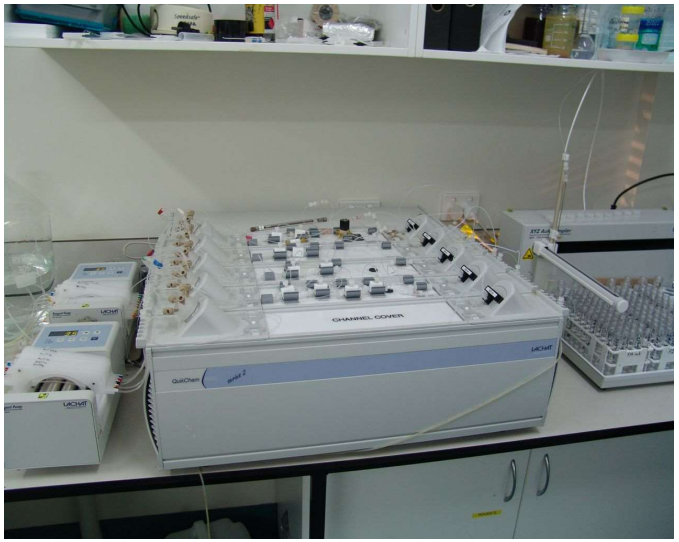
EAL Background

- EAL is an independent University - research, teaching and commercial analytical laboratory.
- Founded around 1992 as self funded analytical facility – now 45+ staff, $5M/yr turnover.
- NATA and ASPAC quality assurances.
- Large range of services (water, soil, leaf, compost, biochar, hair, fertiliser, etc) - ‘State of the Art’ equipment.

Instrumentation- ICPMS, ICPOES, Mantech pH/EC, FIA



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Instrumentation- LECO CNS/ CS

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New Lab (upstairs)

Specialities:

- Agricultural analysis – soil, sap and leaf with emphasis on the biological farming concepts
- Acid sulfate soils, sediments and rock analysis plus input into writing the new National Guidelines
- Metal contamination assessments in soil, plant, produce, dust, water, hair, etc. – techniques mainly around ultra trace ICPMS, seaFAST saline matrix, and HPLC-ICPMS speciation analysis
- Compost, mulch, potting mix, topsoil Aus Standard analysis
- Environmental Nutrient and contamination assessments
- Options for XRD, XRF, SEM with EDAX, particle characterization capabilities, etc.

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EAL with Biological Farming

- Involved with Biological farming for last 20 yrs initially with Elaine Ingham – Soil Foodweb
- Biological and carbon farming enables reduced dependence on inorganic fertilisers.
- SoilCare Inc.– Soil Health Card – dig, look, smell, feel…
- Concept of VSA (Visual Soil Assessment) Agriculture as a 3 legged stool – equal dependence on Biology, Chemistry and Physics (soil structure).

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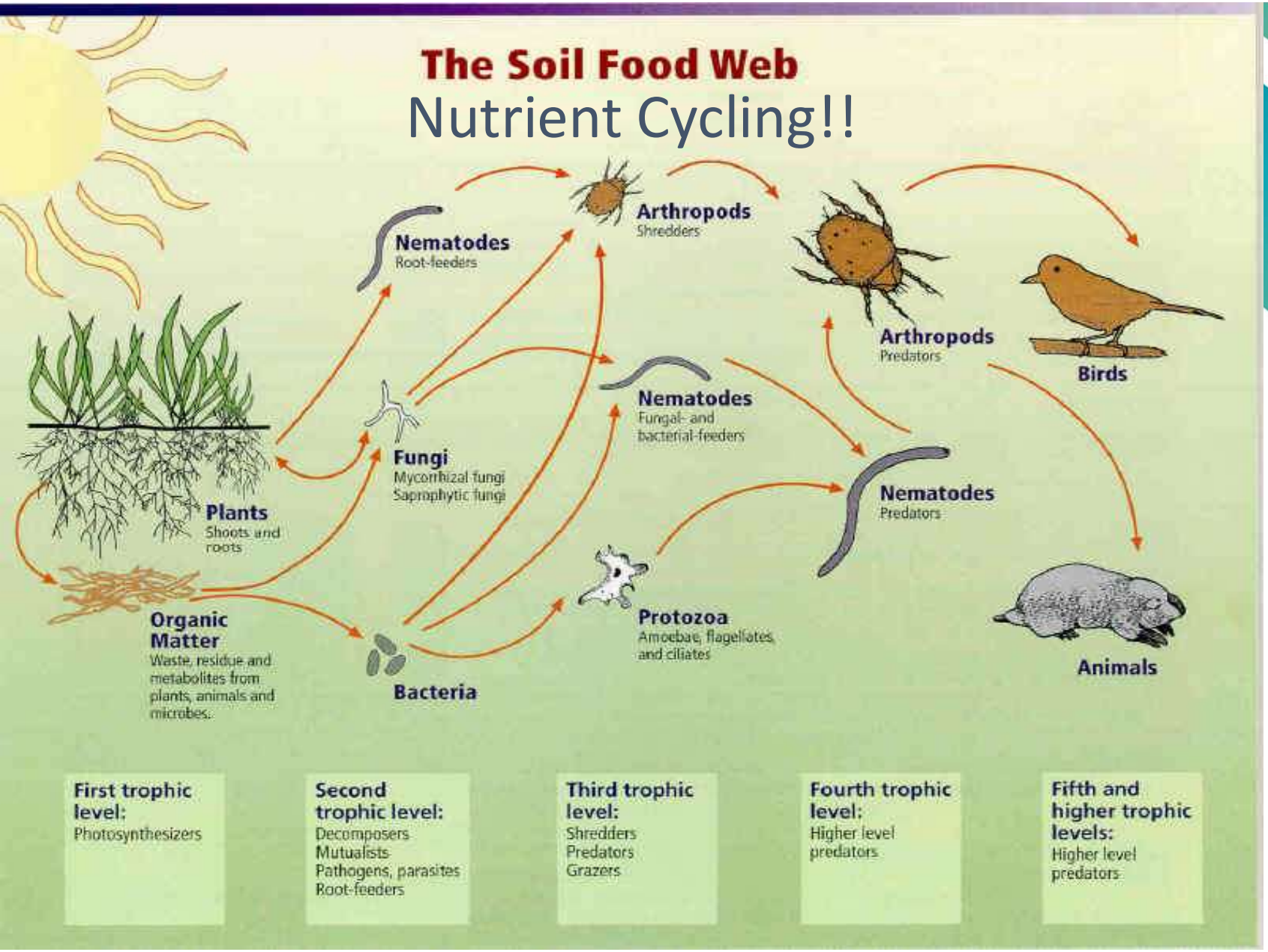
The Soil Food Web

Nutrient Cycling!!



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Macro and Micro Nutrients

- Macro-nutrients

  - primary N, P, K - secondary Ca, Mg, S

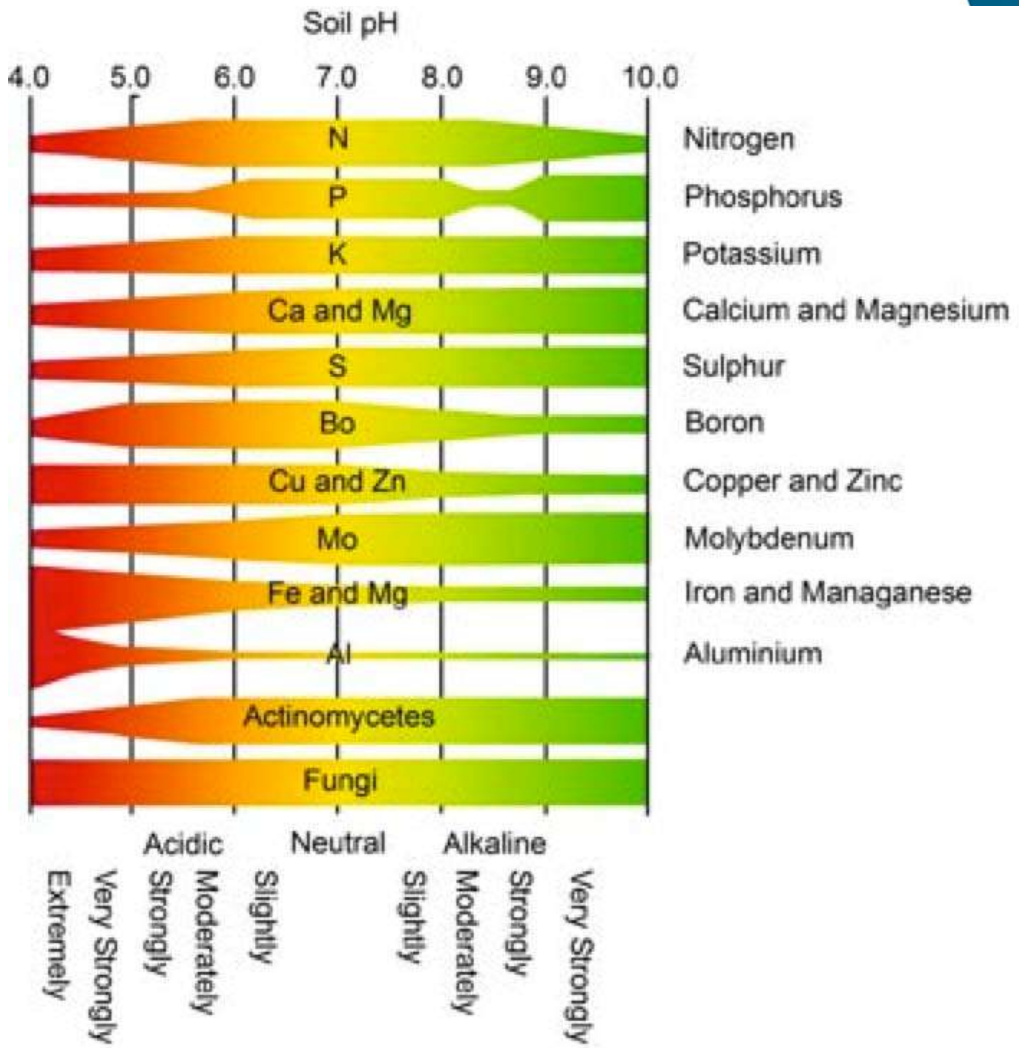
- Micro-nutrients

  - B, Cu, Fe, Cl, Mn, Mo, Zn, Si, Co, Se, …….

- Soil texture is amount of sand, silt, clay and organic matter- texture affects the extent that water and nutrients are retained in the soil profile

- In ‘traditional agriculture’ availability of nutrients dependent on pH (see graphs over page) or by providing soluble salts (ie. fertilisers)

Nutrient availability dependent on soil pH!



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Macronutrients

Nitrogen (N)

- Essential for photosynthesis as is P and Mg. Helps plants with rapid growth, increasing seed and fruit production and improving the quality of leaf and forage crops
- N deficiency is indicated by yellowing of older leaves due to declining chlorophyll. Slow growth and stunted plants are also indicators.

Phosphorus (P)

- Effects rapid growth, encourages blooming and root growth
- Deficiencies show up in older plant tissue. Stunted plants, leaves distorted. Purple or reddish colour
- Fixing of P can make it unavailable to plants. Forms complexes with Ca, Fe, Al, Mn, clay minerals, Al and Fe oxides
- Organic matter contains 1 – 3 % P and makes up about 50 % of P in soil.

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Macronutrients (cont')

Potassium (K)

- Helps in building of protein, fruit quality and reduction of disease
- Deficiencies indicated by scorching along the leaf margins - grow slowly and have small leaves.

Calcium (Ca)

- Essential part of cell walls, provides for normal transport and retention of other elements as well as strength in the plant

Magnesium (Mg)

- Helps activate plant enzymes needed for growth

Sulfur (S)

- Essential for production of protein, enzymes and vitamins
- Improves root growth, seed production, vigorous plant growth and resistance to cold
- Deficiencies of S are often induced by applications of N fertiliser

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Micronutrients

Boron (B)	Helps in use of nutrients and regulates other nutrients
Copper (Cu)	Important for reproductive growth
Chloride (Cl)	Aids plant metabolism
Iron (Fe)	Essential for formation of Chlorophyll
Manganese (Mn)	Involved in breakdown of carbohydrates and nitrogen metabolism
Molybdenum (Mo)	Essential in use of nitrogen
Zinc (Zn)	Essential for the transformation of carbohydrates. Regulates consumption of sugars and regulates plant growth.

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Soil Nutrient References

Glendinning, J. S. (2000). *Australian Soil Fertility Manual.* CSIRO Publishing, Collingwood, Australia.

Peverill, K. I., Sparrow, L. A. and Reuter, D. J. (2001). *Soil Analysis: An Interpretation Manual.* CSIRO Publishing, Collingwood, Australia.

(these are chemical based and not biological)

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Soil Nutrients- Cations / Anions

CATIONS

Ca^{2+} Mg^{2+} K^{+} Na^{+} H^{+} Al^{3+} NH_4^{+}

Fe^{2+} Fe^{3+} Zn^{2+} Cu^{2+} Mn^{2+} B^{3+}

Mo^{2+} Co^{2+} Se^{2+} Si^{4+}

ANIONS

PO_4^{3-} CO_3^{-} Cl^{-} OH^{-} SO_4^{2-}

NO_3^{-} NO_2^{-} Si^{4-}

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Benefits of Monitoring Soil/ Leaf

- WHY test soil?
  - Determine what nutrients are lacking?
  - Determine excessive nutrients.
  - Assess nutrient balance.
  - Relate chemistry to physical characteristics.
  - Directly target fertiliser or compost applications.
- Soil testing determines the current nutrient status of your farm soils.
- Whereas leaf testing provides indication of plant nutrient uptake – nutrient cycling and access.

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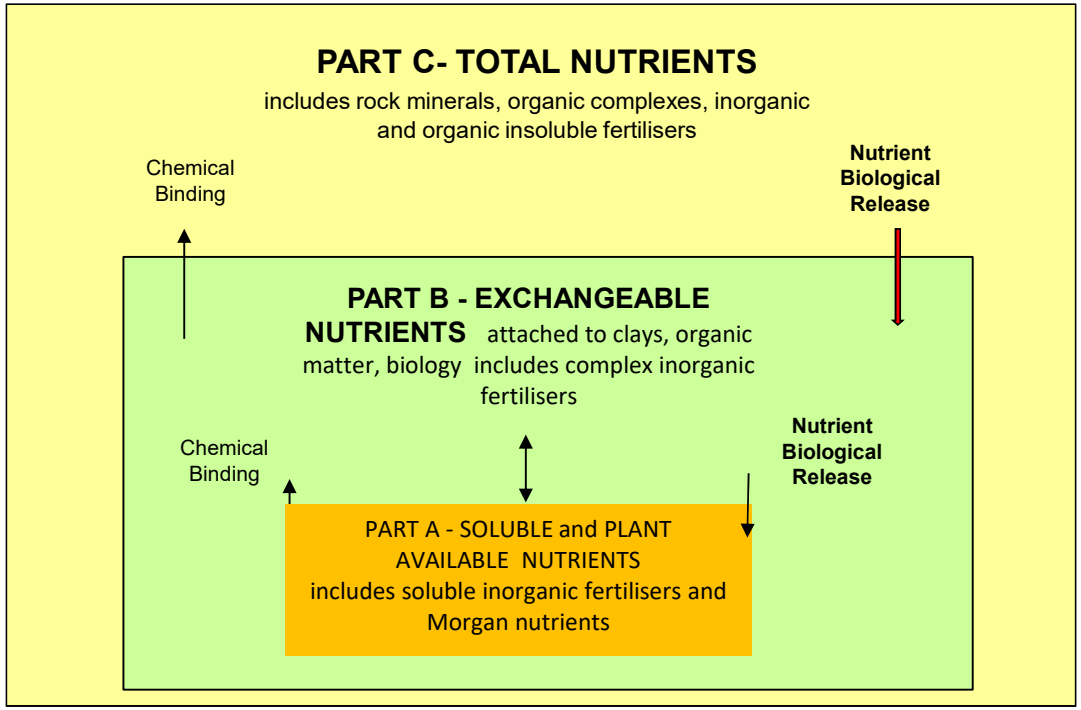
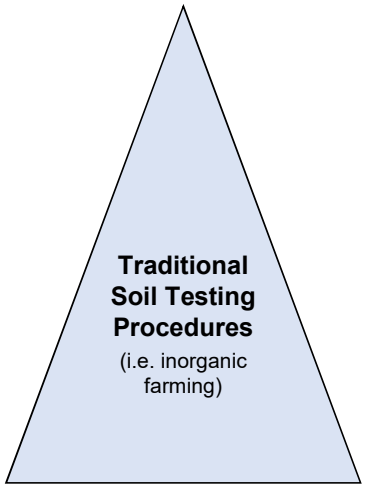
Total Available Soluble Nutrients





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Complete Soil Testing

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PART A - Soluble 'Morgan' Nutrients - Reams

Soluble K, Mg, Ca, S, P, Nitrate, Ammonia

PART B - As per traditional testing

Testing as pH, EC, Extractable plant available phosphorus, exchangeable Na, K, Ca, Mg and Cation Exchange Capacity and Micronutrients

PART C - 'Total' Nutrients

Total acid digestion for N, P, K, Ca, Mg, Na, C, Cu, Zn, Fe, Mn, B, Si, Mo, Co and Se

Soil Composition- XRF Analysis

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Typical Soil Composition		
Element	**Approximate Content (%)**	**Typical Mineral Form**
Oxygen	44 - 49	Oxides of minerals
Silicon	22 - 36	SiO_2
Aluminium	6 - 10	Al_2O_3
Iron	2 - 10	Fe_2O_3
Calcium	1 - 7	CaO
Carbon / LOI	0.1 - 5	Organic Matter/ Carbonates
Potassium	1.5 - 3	K_2O
Magnesium	0.1 - 3	MgO
Sodium	0.01 - 1	Na_2O
Other - Barium, Vanadium, Strontium, Chromium, Nickel, Chloride, Sulfur, Phosphorus, Lanthanum, etc.		Oxides/ Salts
Note: 1 % = 10,000 ppm		

AVERAGE ABUNDANCE OF ELEMENTS

(IN PARTS PER MILLION) (10,000ppm = 1%)

ELEMENT	CRUST	GRANITE	BASALT (Crusher Dust)	SHALE
O	464,000	485,000	441,000	495,000
Si	282,000	323,000	230,000	238,000
Al	81,000	77,000	84,000	92,000
Fe	54,000	27,000	86,000	47,000
Ca	41,000	16,000	72,000	25,000
Na	24,000	28,000	19,000	9,000
Mg	23,000	4,000	45,000	14,000
K	21,000	32,000	8,000	25,000

Reference: Krauskopf, K, 1996. Introduction to Geochemistry, McGraw-Hill Internation.

Interpreting Results

TWO CONCEPTS

- Concept of ‘general guidelines’ based on soil type (Heavy, Medium, Light, Sandy) whereby ‘type’ determined by texture and CEC. This is based on the BCSR concept (Basic Cation Saturation Ratio).

- ‘SLAN’ Sufficiency Level of Available Nutrients. This concept theoretically assumes that the ‘ideal guide’ for sandy soil should be sufficient nutrients for all soils and crops.

- Crop specific adjustments based on above concepts.

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ITEM CODE	AGRICULTURAL SOIL (PACKS)	PRICE excl. GST
RA-PACK-001	**Agricultural - Albrecht/Reams** Includes pH and EC (1:5 water); Available Calcium, Magnesium, Potassium, Ammonium, Nitrate, Phosphate, Sulfur; Exchangeable Sodium, Potassium, Calcium, Magnesium, Hydrogen, Aluminium, Cation Exchange Capacity; Bray I and II Phosphorus; Colwell Phosphorus; Available Micronutrients Zinc, Manganese, Iron, Copper, Boron, Silicon; Total Carbon (TC), Total Nitrogen (TN), Organic Matter, TC/TN Ratio; Basic Colour, Basic Texture.	$110.00
RA-PACK-002	**Agricultural - Albrecht/Reams plus Totals** Includes pH and EC (1:5 water); Available Calcium, Magnesium, Potassium, Ammonium, Nitrate, Phosphate, Sulfur; Exchangeable Sodium, Potassium, Calcium, Magnesium, Hydrogen, Aluminium, Cation Exchange Capacity; Bray I and II Phosphorus; Colwell Phosphorus; Available Micronutrients Zinc, Manganese, Iron, Copper, Boron, Silicon; Total Carbon (TC), Total Nitrogen (TN), TC/TN Ratio, Organic Matter; Basic Colour, Basic Texture; Total Sodium, Potassium, Calcium, Magnesium, Sulfur, Phosphorus, Silicon, Cobalt, Molybdenum, Selenium, Zinc, Manganese, Iron, Copper, Boron and Aluminium.	$160.00
RA-PACK-003	**Agricultural - Albrecht/Reams plus Totals and Heavy Metals** Includes pH and EC (1:5 water); Available Calcium, Magnesium, Potassium, Ammonium, Nitrate, Phosphate, Sulfur; Exchangeable Sodium, Potassium, Calcium, Magnesium, Hydrogen, Aluminium, Cation Exchange Capacity; Bray I and II Phosphorus; Colwell Phosphorus; Available Micronutrients Zinc, Manganese, Iron, Copper, Boron, Silicon; Total Carbon (TC), Total Nitrogen (TN), TC/TN Ratio, Organic Matter; Basic Colour, Basic Texture; Total Sodium, Potassium, Calcium, Magnesium, Sulfur, Phosphorus, Silicon, Cobalt, Molybdenum, Selenium, Zinc, Manganese, Iron, Copper, Boron and Aluminium; Heavy Metals Silver, Arsenic, Lead, Chromium, Nickel, Cadmium, Mercury.	$180.00

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EAL Routine Ag Soil Test

Table part 1 of 4 - Soluble Reams Nutrients

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			Sample 1	*Heavy Soil*	*Medium Soil*	*Light Soil*	*Sandy Soil*
		Sample ID:	1- Soil				
		Crop:	Pecans				
		Client:		*Clay*	*Clay Loam*	*Loam*	*Loamy Sand*
	Parameter	**Method reference**	**H8954/1**	**Indicative guidelines - refer to Notes 6 and 8**			
	Soluble Calcium (mg/kg)	**Inhouse S10 - Morgan 1	1419	*1150*	*750*	*375*	*175*
	Soluble Magnesium (mg/kg)		474	*160*	*105*	*60*	*25*
	Soluble Potassium (mg/kg)		92	*113*	*75*	*60*	*50*
	Soluble Phosphorus (mg/kg)		4.4	*15*	*12*	*10*	*5.0*
	Phosphorus (mg/kg P)	**Rayment & Lyons 2011 - 9E2 (Bray 1)	26	*45 note 8*	*30 note 8*	*24 note 8*	*20 note 8*
		**Rayment & Lyons 2011 - 9B2 (Colwell)	168	*80*	*50*	*45*	*35*
		**Inhouse S3A (Bray 2)	82	*90 note 8*	*60 note 8*	*48 note 8*	*40 note 8*
	Nitrate Nitrogen (mg/kg N)	**Inhouse S37 (KCl)	7.5	*15*	*13*	*10*	*10*
	Ammonium Nitrogen (mg/kg N)		2.3	*20*	*18*	*15*	*12*
	Sulfur (mg/kg S)		9.1	*10.0*	*8.0*	*8.0*	*7.0*
	pH	Rayment & Lyons 2011 - 4A1 (1:5 Water)	6.35	*6.5*	*6.5*	*6.3*	*6.3*
	Electrical Conductivity (dS/m)	Rayment & Lyons 2011 - 3A1 (1:5 Water)	0.056	*0.200*	*0.150*	*0.120*	*0.100*
	Estimated Organic Matter (% OM)	**Calculation: Total Carbon x 1.75	5.7	*> 5.5*	*>4 .5*	*> 3.5*	*> 2.5*

Table part 2 of 4 - Exchangeable Cations

					Clay	*Clay Loam*	*Loam*	*Loamy Sand*
	Exchangeable Calcium	**(cmol$_+$/kg)**	Rayment & Lyons 2011 - 15D3 (Ammonium Acetate)	15.82	*15.6*	*10.8*	*5.0*	*1.9*
		(kg/ha)		7100	*7000*	*4816*	*2240*	*840*
		(mg/kg)		3170	*3125*	*2150*	*1000*	*375*
	Exchangeable Magnesium	**(cmol$_+$/kg)**		6.64	*2.4*	*1.7*	*1.2*	*0.60*
		(kg/ha)		1809	*650*	*448*	*325*	*168*
		(mg/kg)		807	*290*	*200*	*145*	*75*
	Exchangeable Potassium	**(cmol$_+$/kg)**		0.59	*0.60*	*0.50*	*0.40*	*0.30*
		(kg/ha)		514	*526*	*426*	*336*	*224*
		(mg/kg)		229	*235*	*190*	*150*	*100*
	Exchangeable Sodium	**(cmol$_+$/kg)**		0.18	*0.3*	*0.26*	*0.22*	*0.11*
		(kg/ha)		93	*155*	*134*	*113*	*57*
		(mg/kg)		42	*69*	*60*	*51*	*25*
	Exchangeable Aluminium	**(cmol$_+$/kg)**	**Inhouse S37 (KCl)	0.01	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		2	*121*	*101*	*73*	*30*
		(mg/kg)		<1	*54*	*45*	*32*	*14*
	Exchangeable Hydrogen	**(cmol$_+$/kg)**	**Rayment & Lyons 2011 - 15G1 (Acidity Titration)	0.02	*0.6*	*0.5*	*0.4*	*0.2*
		(kg/ha)		<1	*13*	*11*	*8*	*3*
		(mg/kg)		<1	*6*	*5*	*4*	*2*
	Effective Cation Exchange Capacity (ECEC) (cmol$_+$/kg)		**Calculation: Sum of Ca,Mg,K,Na,Al,H (cmol$_+$/kg)	23.27	*20.1*	*14.3*	*7.8*	*3.3*
	Calcium (%)		**Base Saturation Calculations - Cation cmol$_+$/kg / ECEC x 100	68.0	*77.6*	*75.7*	*65.6*	*57.4*
	Magnesium (%)			28.6	*11.9*	*11.9*	*15.7*	*18.1*
	Potassium (%)			2.5	*3.0*	*3.5*	*5.2*	*9.1*
	Sodium - ESP (%)			0.8	*1.5*	*1.8*	*2.9*	*3.3*
	Aluminium (%)			0.0	*6.0*	*7.1*	*10.5*	*12.1*
	Hydrogen			0.1				
	Calcium/Magnesium Ratio		**Calculation: Calcium / Magnesium (cmol$_+$/kg)	2.4	*6.5*	*6.4*	*4.2*	*3.2*

Table part 3 of 4 - Micronutrients, miscellaneous

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				Clay	Clay Loam	Loam	Loamy Sand
	Zinc (mg/kg)	Rayment & Lyons 2011 - 12A1 (DTPA)	3.8	*6.0*	*5.0*	*4.0*	*3.0*
	Manganese (mg/kg)		15	*25*	*22*	*18*	*15*
	Iron (mg/kg)		283	*25*	*22*	*18*	*15*
	Copper (mg/kg)		1.9	*2.4*	*2.0*	*1.6*	*1.2*
	Boron (mg/kg)	**Rayment & Lyons 2011 - 12C2 (Hot $CaCl_2$)	0.64	*2.0*	*1.7*	*1.4*	*1.0*
	Silicon (mg/kg Si)	**Inhouse S11 (Hot CaCl2)	84	*50*	*45*	*40*	*35*
	Total Carbon (%)	Inhouse S4a (LECO Trumac Analyser)	3.25	*> 3.1*	*> 2.6*	*> 2.0*	*> 1.4*
	Total Nitrogen (%)		0.24	*> 0.30*	*> 0.25*	*> 0.20*	*> 0.15*
	Carbon/Nitrogen Ratio	**Calculation: Total Carbon/Total Nitrogen	13.8	*10–12*	*10–12*	*10–12*	*10–12*
	Basic Texture	**Inhouse S65	Loam	..	..	..	..
	Basic Colour		Brownish	..	..	..	..
	Chloride Estimate (equiv. mg/kg)	**Calculation: Electrical Conductivity x 640	36	..	..	..	..

Table part 4 of 4 – Totals (RA-PACK-002) – Contaminants (RA-PACK-003)

			Clay	Clay Loam	Loam	Loamy Sand
	Total Calcium (mg/kg)	Rayment & Lyons 2011 - 17C1 Aqua Regia	*1000–10 000 Ca*			
	Total Magnesium (mg/kg)		*500–5000 Mg*			
	Total Potassium (mg/kg)		*200–2000 K*			
	Total Sodium (mg/kg)		*100–500 Na*			
	Total Sulfur (mg/kg)		*100–1000 S*			
	Total Phosphorus (mg/kg)		*400–1500 P*			
	Total Zinc (mg/kg)		*20–50 Zn*			
	Total Manganese (mg/kg)		*200–2000 Mn*			
	Total Iron (mg/kg)		*1000–50 000 Fe*			
	Total Copper (mg/kg)		*20–50 Cu*			
	Total Boron (mg/kg)		*2–50 B*			
	Total Silicon (mg/kg)		*1000–3000 Si*			
	Total Aluminium (mg/kg)		*2000–50 000 Al*			
	Total Molybdenum (mg/kg)		*0.5–3.0 Mo*			
	Total Cobalt (mg/kg)		*5–50 Co*			
	Total Selenium (mg/kg)		*0.1–2.0 Se*			
	Total Cadmium (mg/kg)		*<1 Cd*			
	Total Lead (mg/kg)		*2–200 Pb*			
	Total Arsenic (mg/kg)		*1–50 As*			
	Total Chromium (mg/kg)		*5–1000 Cr*			
	Total Nickel (mg/kg)		*5–500 Ni*			
	Total Mercury (mg/kg)		*< 0.2 Hg*			
	Total Silver (mg/kg)		*.. 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

Understanding your EAL soil results

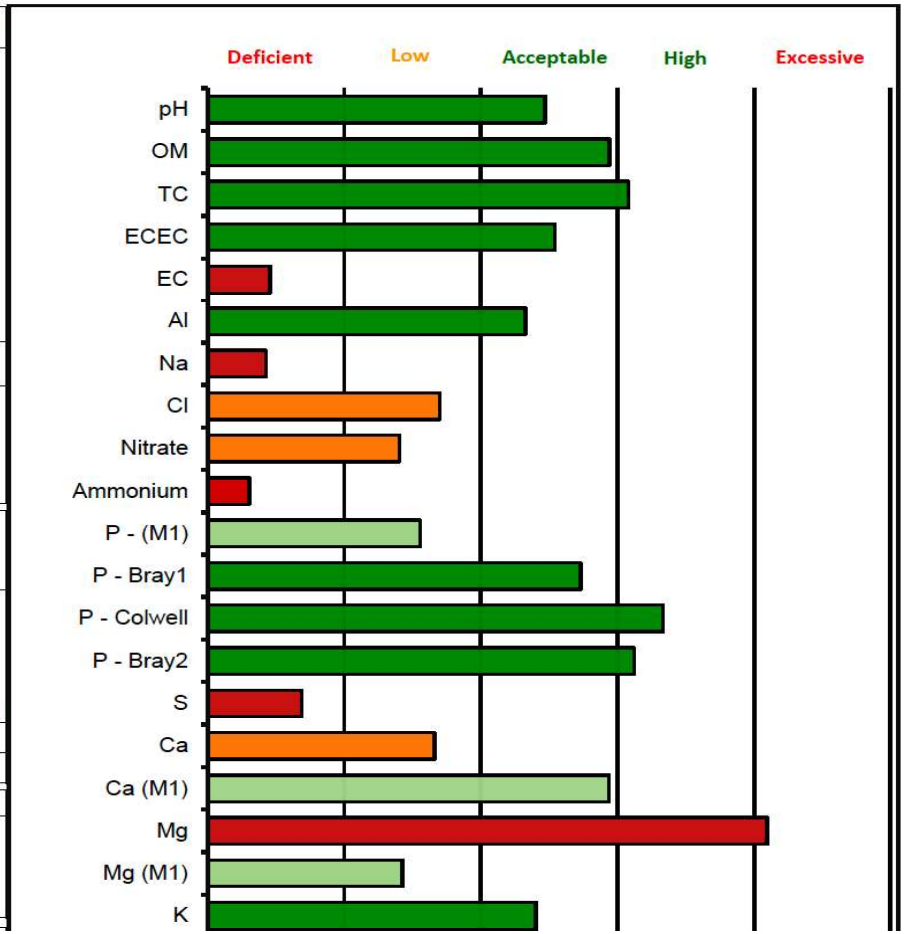
	Soil Acidity - Is the water pH >6.5 or $CaCl_2$ pH >5.5 – hence no major problem. >7pH indicates alkaline soil. Soil with pH below 4.5 often has high kg/ha exchangeable hydrogen and aluminium (and likely high % exchangeable H and Al).
	Cation Exchange Capacity - Using the ECEC or CEC is the soil heavy, 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.
	PBI (Phosphorus Buffer Index- no units) - The higher the value up to 1000 the more absorptive the soil is to P hence low PBI soil has limited ability to tie up applied P.
	Acid Extractable Nutrients - If total available nutrients were analysed then use numbers as a guide to compare to assess store of nutrients.

SOIL TEST RESULTS

Client:	
Crop:	**Pecan**
Sample ID:	**Pecan**

Job No:	G1348
No of Samples:	2
Date Supplied:	
Supplied by:	

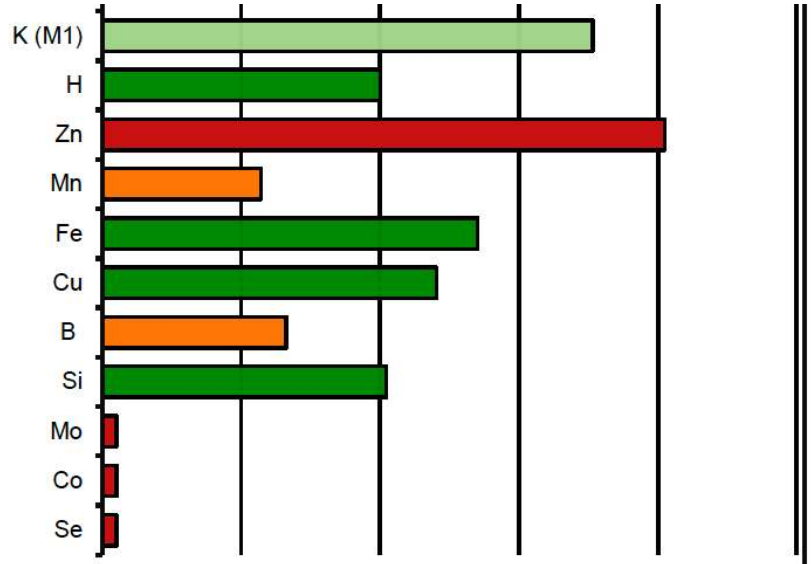
		Unit	Results	Desired Level
	pH (Water)	Unit	6.44	6.40
	Organic Matter (OM)	%	5.9	4 - 6
	Total Carbon	%	3.36	2.2 - 3.2
	Total Nitrogen	%	0.28	>0.25
	Carbon : Nitrogen Ratio	Unit	12.2	10-12
	Effective Cation Exchange Capacity (ECEC)	cmol+/Kg	12.3	12-16
	Total Exchange Capacity (TEC)	cmol+/Kg	13.5	
	Electrical Conductivity (EC 1:5)	dS/m	0.064	0.200
	Aluminium	mg/kg	5	<15
	Sodium	%	0.6	2.20
	Chloride Estimate	mg/kg	41	<200
	Actual Chloride	mg/kg	N/T	<200
N	Total Nitrogen	%	0.28	>0.25
	Nitrogen - Nitrate	mg/kg	9	12.3
	Nitrogen - Ammonium	mg/kg	3	18
P	Phosphorus Buffering Index (PBI)	Unit	N/T	70 - 140
	Phosphorus - Bray 1	mg/kg	34	30
	Phosphorus - Colwell	mg/kg	113	50
	Phosphorus - Bray 2	mg/kg	96	59
	Total Phosphorus	mg/kg	N/T	400 - 1,500
K	Potassium	mg/kg	229	197
S	Sulphur	mg/kg	8.3	20
Reams	Morgan 1 Extract (M1)			
	Calcium	mg/kg	997	725
	Magnesium	mg/kg	180	197
	Potassium	mg/kg	127	74
	Phosphorus	mg/kg	7.3	12



			mg/kg	kg/Ha
Cations	Calcium	Desired	2073	4656
		Found	1862	4171
		Deficit		485
	Magnesium	Desired	196	441
		Found	280	628
		Deficit		0
	Potassium	Desired	197	442
		Found	229	512
		Deficit		0
	Sodium	Desired	59	133
		Found	18	40
		Deficit		93

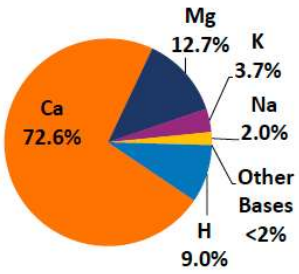
Trace Elements	Zinc	mg/kg	8.8	4.9
	Manganese	mg/kg	16.4	58
	Iron	mg/kg	283	50 - 400
	Copper	mg/kg	3.34	1.97
	Boron	mg/kg	0.95	1.68
	Silicon	mg/kg	50	45
	Molybdenum	mg/kg	N/T	0.8 - 2.0
	Cobalt	mg/kg	N/T	2.5 - 10
	Selenium	mg/kg	N/T	0.5 - 2.0

% Base Saturation	Calcium & Magnesium RATIO		4.0	5.6
	Calcium	% Ca	68.7	73
	Magnesium	% Mg	17	13
	Potassium	% K	4.3	4
	Sodium (ESP)	% Na	0.6	2.2
	Aluminium	% Al	0.4	<2
	Hydrogen	% H	9.0	9.0

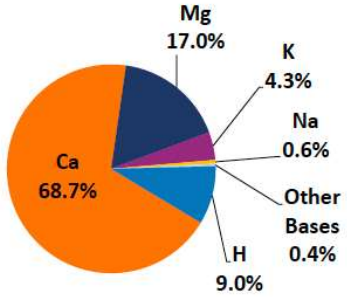


Base Saturation (%)

Standard % Base Saturation



Found: Pecan



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FERTI-TECH
5 YOOKSON DRIVE PICTON WA 6230
PH (08) 9725 6877 EMAIL: info@fertitech.com

Results Checked By:
Kris Saville
Senior Agricultural Analyst

Environmental Issues?

- **Healthy soils function to:**
  - **Increase plant health and productivity**
  - **Sustain biological activity**
  - **Store and cycle water and nutrients**
  - **Decompose organic matter**
  - **Inactivate (bind) toxic compounds**
  - **Suppress pathogens**
  - **Protect water quality and enhance catchment health**

- We want our soils healthy and balanced with nutrients - A balance exists between optimum soil nutrients and nutrient runoff (ie. waste and environmental pollution)

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Plant Leaf Testing

- Sample collection most important – often last seasons growth, 3rd whirl back (refer guide)
- Total Acid digest hence ‘TOTAL ELEMENT’
- Reproducibility between labs generally very good
- Bias if samples are collected after foliar application (with no leaf washing).
- Total analysis of N, P, K, Ca, Mg, Na, S, C, Fe, Mn, Cu, Zn, B, Mo, Co, Si)

EAL Plant Leaf Testing Suite

PA-PACK-001	**Plant Testing** Includes Total Nitrogen (TN), Total Carbon (TC), Total Sulfur (TS); Sodium, Potassium, Calcium, Magnesium, Phosphorus, Silicon, Cobalt, Molybdenum, Zinc, Manganese, Iron, Copper, Boron.	$50.00

EAL Plant Leaf Sampling Guide

- Paper bags are best for leaf sample collection.
- We can analyse a single leaf but a couple hundred grams best – the lab 40˚C dries and grinds this mass.
- If crop problems: collection of leaves from problem plants and comparison with leaves collected from good plants is an easy solution to locating deficiencies/ toxicities.
- Reference for sample collection and nutrient guide:
  - Reuter D.J. & Robinson J.B. 1986 Plant Analysis An Interpretation Manual. Inkata Press.
  - Bryson, Mills, Sasseville, Joes and Barker, 2014. Plant Analysis Manual III, MicroMacro Publishing, ASPAC.

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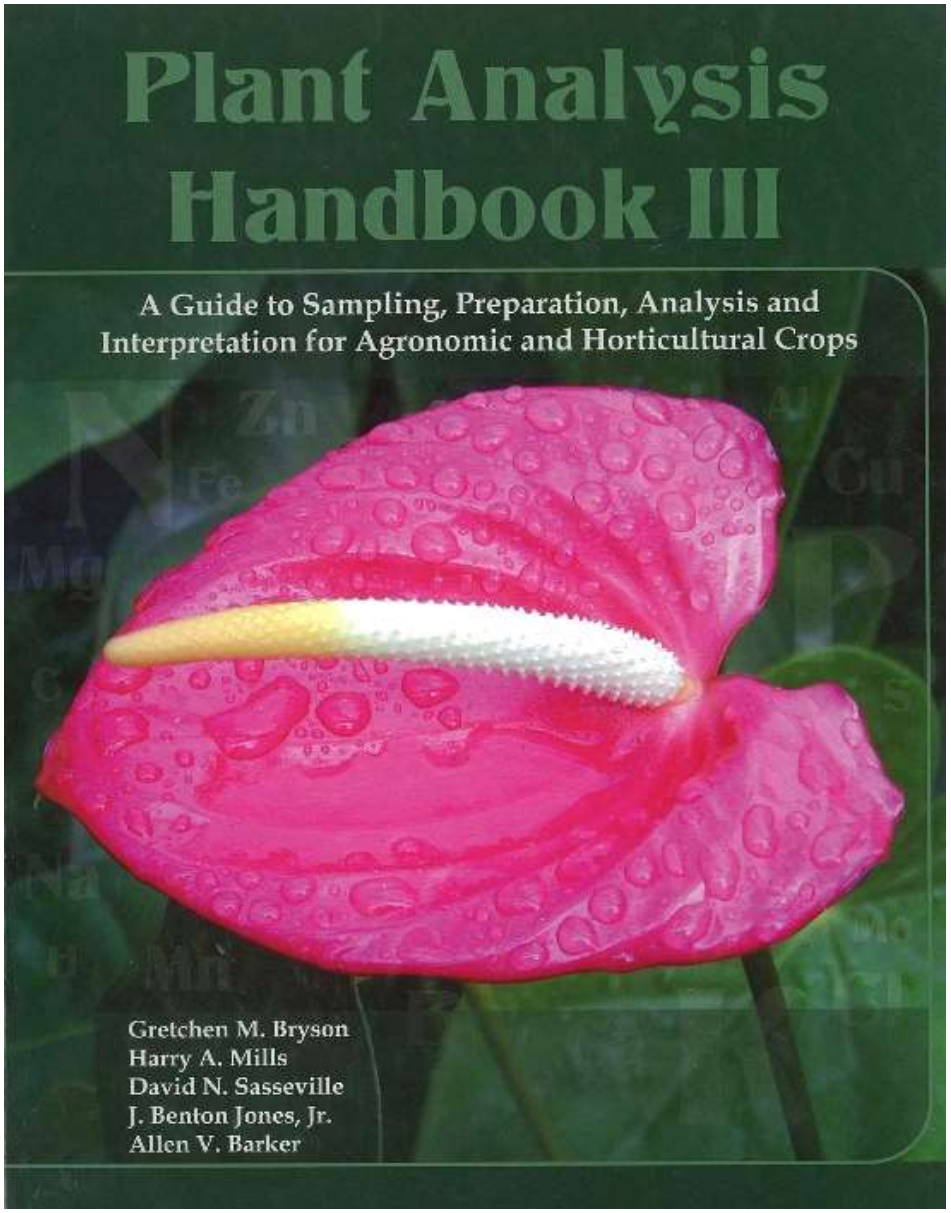

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PLANT TISSUE ANALYSIS REPORT

1 samples supplied by AXXXX

Analysis requested by XXX

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			Sample 1	Sufficiency Range	
		Sample ID:	Pecan Leaf		
		(IGNORE/HIDE)	CODEROW		
		Crop:	Pecan Leaf	PECAN	
		Season:		56-84 days after terminal bud set	
		Plant Part:		25 leaflet pairs from new growth	
		Client:			
Parameter		**Method reference**	**i1149**	*Lower*	*Upper*
Nitrogen (%)		LECO Trumac Analyser - Inhouse S4a	2.37	1.70	1.90
Phosphorus (%)		Nitric Acid digest - APHA 3125 ICPMS	0.28	0.15	0.20
Potassium (%)		Nitric Acid digest - APHA 3125 ICPMS	0.86	1.25	1.50
Sulfur (%)		LECO Trumac Analyser - Inhouse S4a	0.21	0.18	0.30
Carbon (%)		LECO Trumac Analyser - Inhouse S4a	46.5	..	..
Magnesium (%)		Nitric Acid digest - APHA 3125 ICPMS	0.52	0.35	0.75
Sodium (%)		Nitric Acid digest - APHA 3125 ICPMS	0.06	..	..
Copper (mg/kg)		Nitric Acid digest - APHA 3125 ICPMS	32	8	40
Zinc (mg/kg)		Nitric Acid digest - APHA 3125 ICPMS	275	50	100
Manganese (mg/kg)		Nitric Acid digest - APHA 3125 ICPMS	1,511	20	500
Iron (mg/kg)		Nitric Acid digest - APHA 3125 ICPMS	172	50	300
Boron (mg/kg)		Nitric Acid digest - APHA 3125 ICPMS	86	50	60
Cobalt (mg/kg)		Nitric Acid digest - APHA 3125 ICPMS	3.7	..	..
Silicon (mg/kg)		**Nitric Acid digest - APHA 3125 ICPMS	771	..	..
Nitrogen : Sulfur Ratio		**Calculations	11.4	..	..
Nitrogen : Phosphorus Ratio			8.6	..	..
Nitrogen : Potassium Ratio			2.8	..	..
Carbon : Nitrogen Ratio			19.6	..	..
Crude Protein (%)		**Calculation: Total Nitrogen x 6.25	14.8	..	..

CSIRO Plant Reference Guide V3

Scientific Name	Carya illinoinensis
Common Name	Pecan
Collected From	Production orchards
Plant Part	25 leaflet pairs from new growth
Season	56-84 days after terminal bud set
Data Type	Sufficiency Range
Cultivars Used	Species only

Macronutrients %		Micronutrients ppm	
N	1.70 - 1.80	Fe	50 - 300
P	0.15 - 0.20	Mn	20 - 500
K	1.25 - 1.50	B	50 - 60
Ca	1.00 - 1.50	Cu	8 - 40
Mg	0.35 - 0.75	Zn	50 - 100
S	0.18 - 0.30	Mo	0.01 - 1.0

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CSIRO Plant Reference Guide V2

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Pecan (*Carya illinoensis*)

Nutrient	Concentration range						Comments
	Deficient	Marginal	Critical (deficiency)	Adequate	High	Toxic or Excessive	
				Sampling			
Growth stage: Shell hardening to early kernel development (Feb in New South Wales).							
Plant part: Pairs of leaflets from midway along youngest fully expanded leaf on fruiting wood. Take 10 leaflets from each of 10 trees to represent a planting							
How established: Compiled by Cresswell (1983) who used the method of Jones (1974) in New South Wales, see also Weir and Cresswell (1993). Other use and Sparks (1978).							
N(%)	<1.7	1.7-2.4		2.5-3.0	3.1-3.9	>3.9	
P(%)		<0.12		0.12-0.3	0.3-0.4	>0.4	
K(%)	<0.36	0.36-0.74		0.75-1.5	1.6-3.5	>3.5	
S(%)		<0.15		0.15-0.25	>2.5		
Ca(%)		<0.7		0.7-2.5	2.6-3.2		
Mg(%)	<0.16	0.17-0.29		0.3-0.7	0.8-0.9	>0.9	
Na(%)				<0.1	0.11-0.4		
Cl(%)				<0.5	0.51-1.0		
Cu(mg/kg)		2-4		5-50	51-350		(F)
Zn(mg/kg)	<30	30-49		50-100	101-250		(F)
Mn(mg/kg)	<100	100-149		150-500	501-2500	>2500	(F)
Fe(mg/kg)		<50		50-300			(D)
B(mg/kg)	<6	6-19		20-50	51-650	>650	

CSIRO Plant Reference Guide V1

PECAN (*Carya illinoensis*)

Sampling

Growth stage: Shell hardening to early kernel development (February in New South Wales).

Plant part: Pairs of leaflets from midway along youngest fully expanded leaf on fruiting wood. Take 10 leaflets from each of 10 trees to represent a planting. Select leaflets from branches up to 2 m above the ground.

How established

Compiled by G. C
Wales. Other use
and Sparks (197

	Concentration range						
Nutrient	Deficient	Marginal	Critical	Adequate	High	Toxic or Excessive	
N(%)	<1.7	1.7–2.4		2.5–3.0	3.1–3.9	>3.9	
P(%)		<0.12		0.12–0.3	>0.3		
K(%)	<0.36	0.36–0.74		0.75–1.5	1.6–3.5	>3.5	
S(%)		<0.15		0.15–0.25	>0.25		
Ca(%)		<0.7		0.7–2.5	>2.5		
Mg(%)		<0.3		0.3–0.7	>0.7		
Cu(mg/kg)		<4		4–50	>50		(F)
Zn(mg/kg)	<30	30–49		50–100	>250		(F)
Mn(mg/kg)	<100	100–149		150–500	>500	>2500	(F)
Fe(mg/kg)		<50		50–300	>300		(D)
B(mg/kg)	<6	6–19		20–50	>50	>650	

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Conclusion

- Soil testing for regenerative farming about targeting nutrient applications (ie. compost)
- Soil testing to determine stored nutrients to access biologically
- Soil guidelines based on soil type with adjustments for crop type
- Carbon is a key nutrient essential for soil health
- Leaf testing a tool to assess nutrient deficiency or toxicity
- A discounted quote will be provided to APA expire EOY

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QUESTIONS!


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