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NURTURING CROPS

VEGETABLE CROP NUTRITION SERIES
Soil Test Interpretation – Webinar 1

Doris Blaesing, RMCG

Gordon Rogers, AHR

Horticulture Innovation Australia

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Soil Testing – Why?

- **Smart choice -** fertiliser type and amount selection, timing and placement
- **Savings** - higher fertiliser recovery
- **Knowledge -** realistic nutrition planning
- **Net profit -** improve salable yield
- **Environment -** control pollution

MONITOR 2 MANAGE

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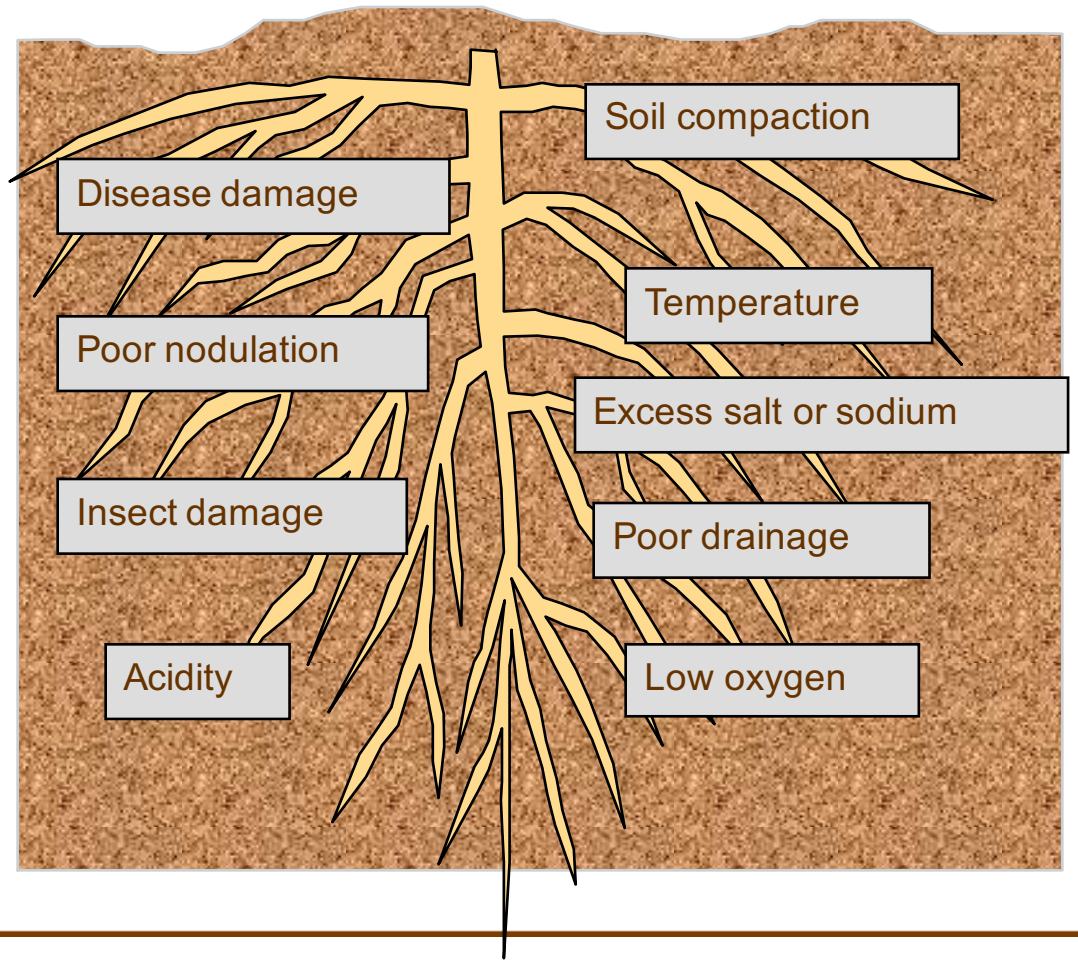
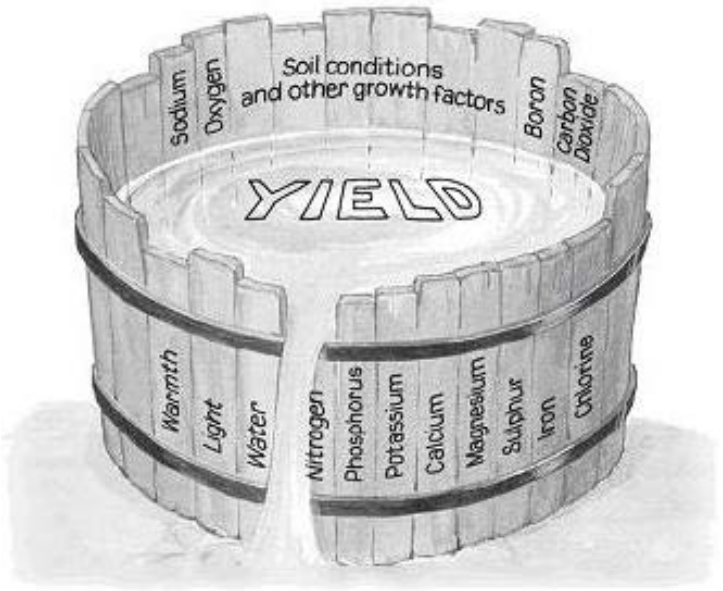
Factors affecting nutrient uptake

The limiting factor is not always nutritional!





Other factors are e.g.:

Crop stress
Irrigation
Weather
Crop management

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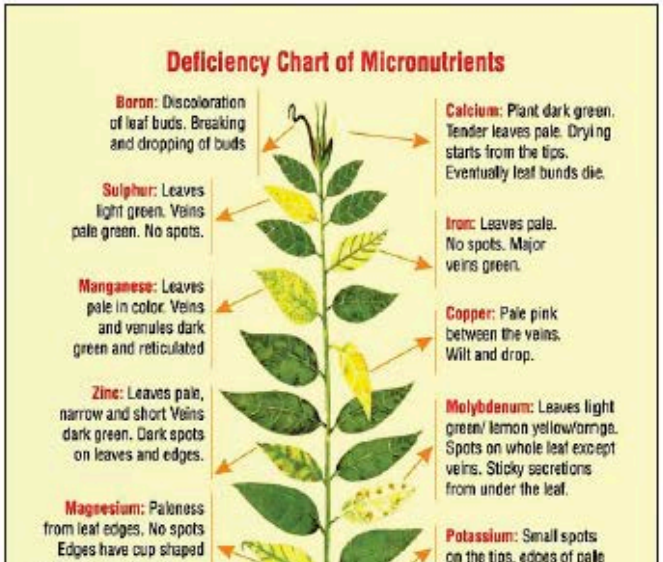
Nutrient function: refer fact sheet

Apart from water (H^2O), carbon dioxide (CO^2) and oxygen (O^2), all plants require mineral nutrients in order to grow. Plant nutrients are commonly split into two categories:

- Major elements (macronutrients) that are required in relatively large quantities by plants, and
- Trace elements (micronutrients) that are essential for plant growth, but are only required in small amounts.

All elements must be available in a form that is useable by the plant, and in balanced concentrations that allow optimum plant growth.

The schematic image of a tomato plant shows a simple diagram of the plant and root interactions with the various available major and trace elements in the soil. Each of the necessary nutrients in plant growth has a different function in supporting the growth and performance of the plant.



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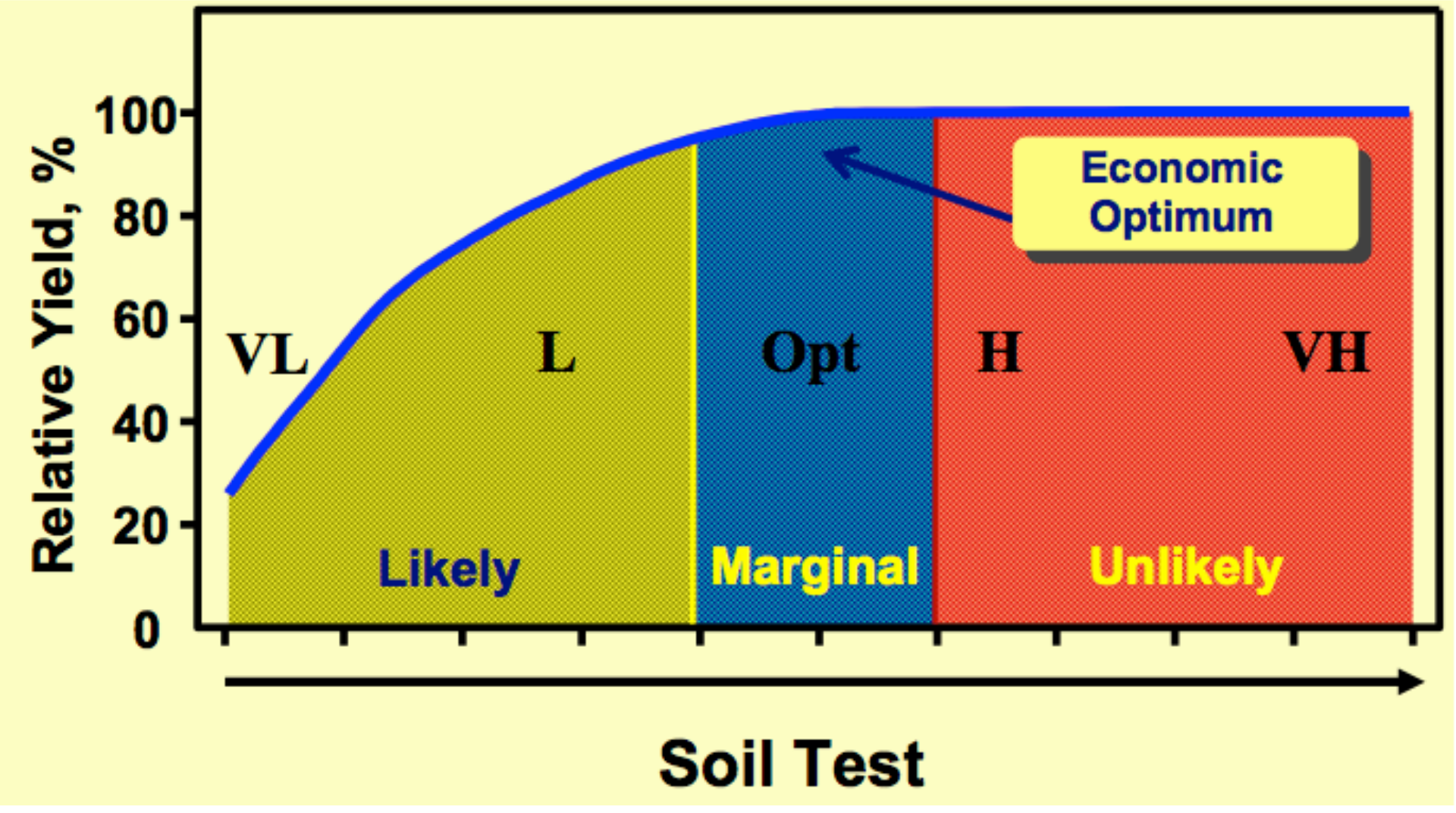
What nutrient levels to aim for

Estimate potential nutrient availability and crop response



How nutrients are held in soils

Positively charged ***cations*** are held on clay particles and humus

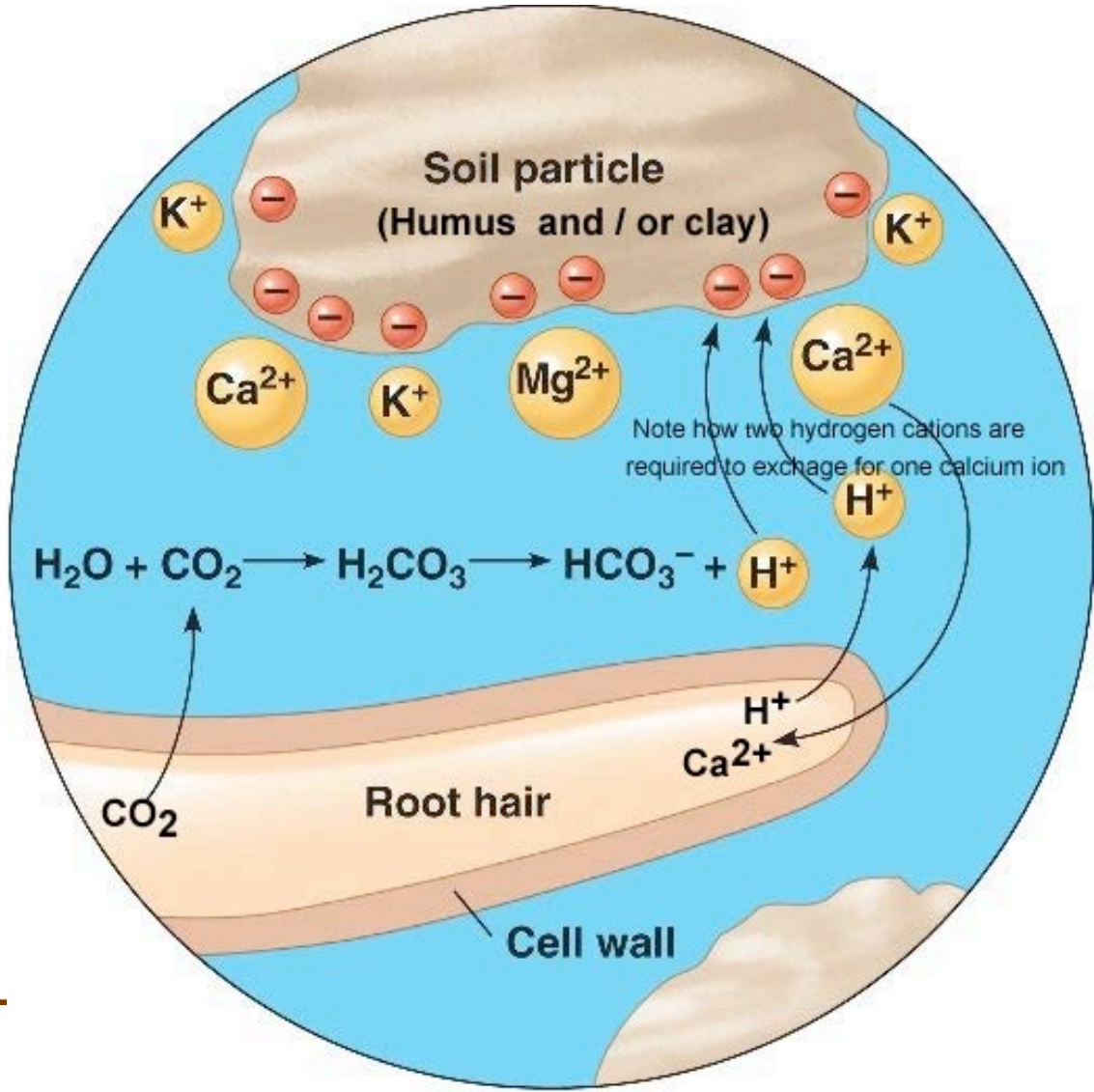
CEC and buffering

Cations: K^+, Mg^+, Ca^{2+}, Zn^{2+}, Fe^{2+}, Mn^{2+}, Cu^{2+}

Anions leach easily

Anions: NO_3^-, SO_4^{2-}, BO_3^{3-}, MoO_4^{2-}, Cl^-

Phosphorus: $H_2PO_4^-$ but complexes tightly with Al and Fe in acid soils and Ca in alkaline soils – immobile



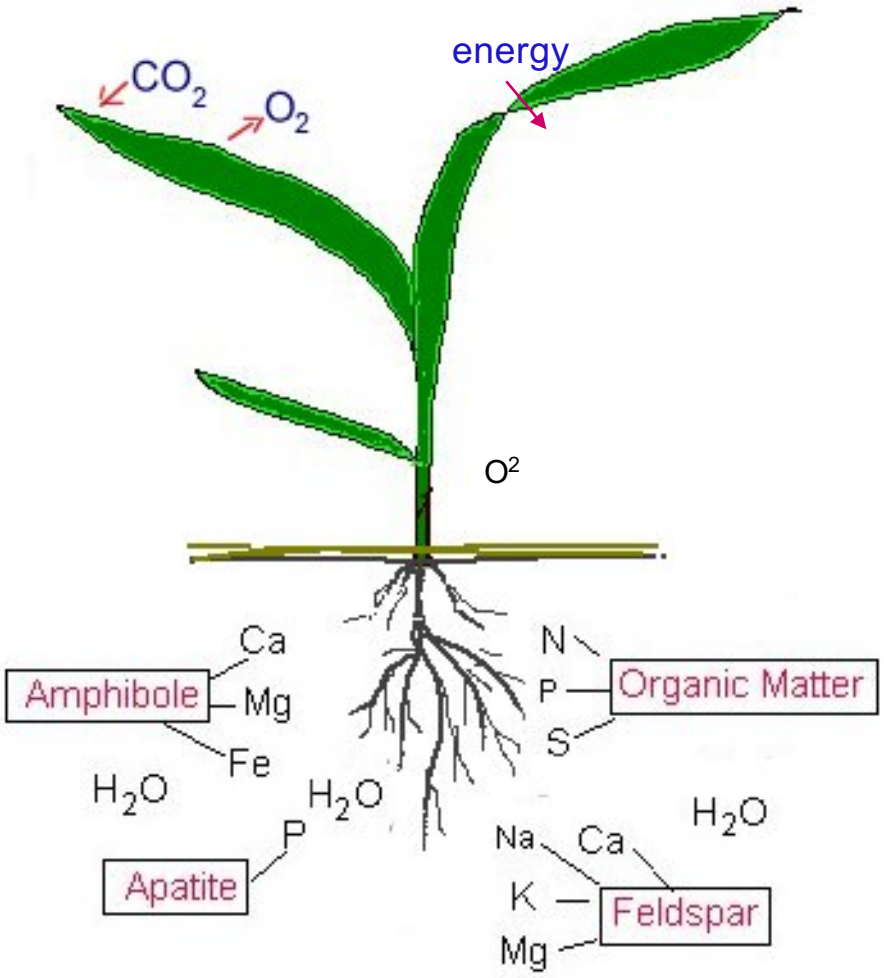
How nutrients move through soil and uptake mechanisms

Processes by which nutrients move through the soil are:

Mass flow

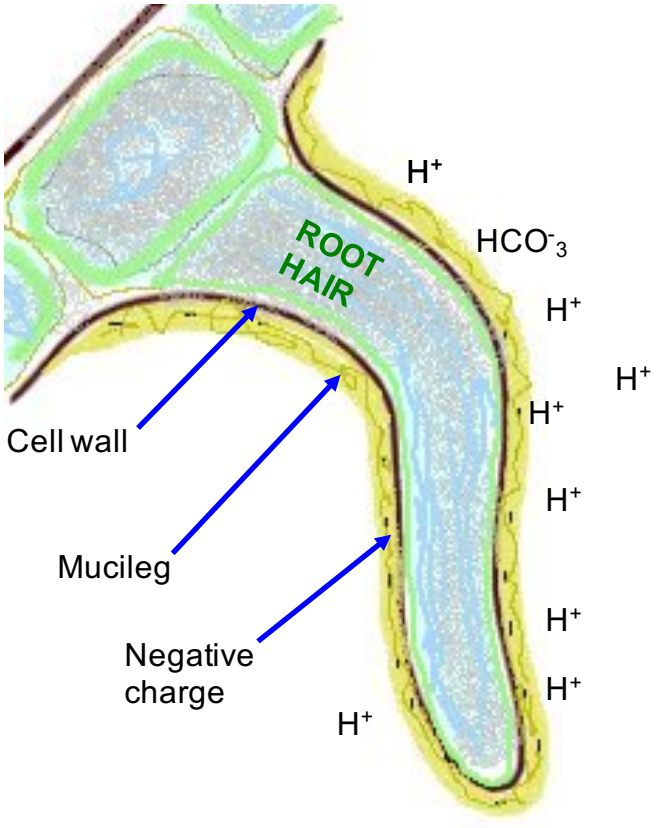
Diffusion

Root Interception

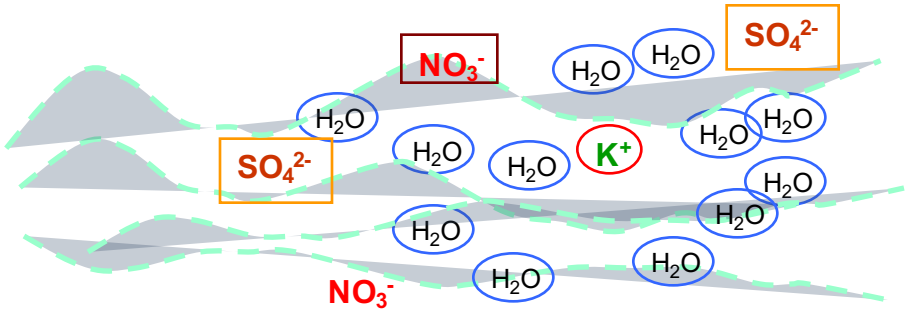


Knowing these processes is important when preparing nutrient management plans!

Mass flow



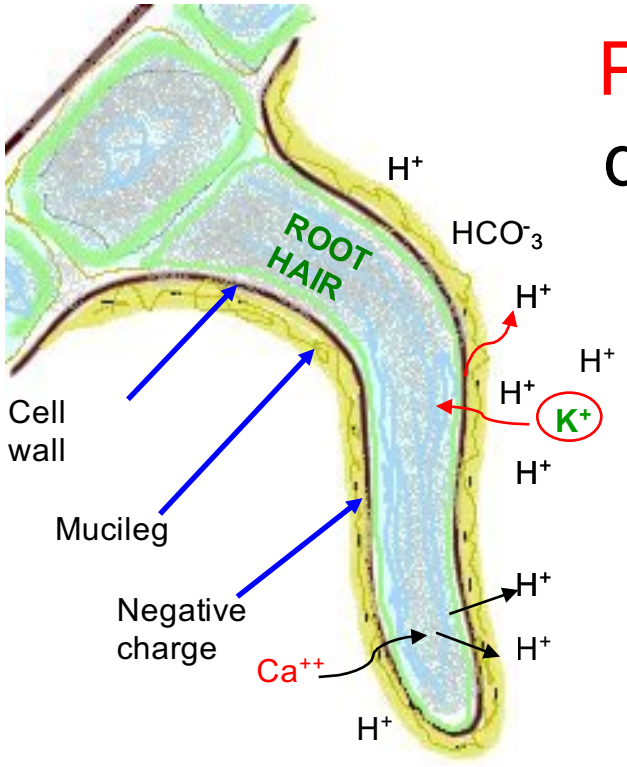
Most NO_3^- and SO_4^{2-} move with water to the roots.



Plant transpiration provides needed driving force for root to uptake

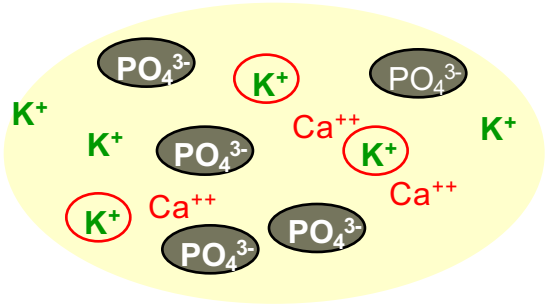
This is the most efficient way nutrients move to the root zone.

Diffusion



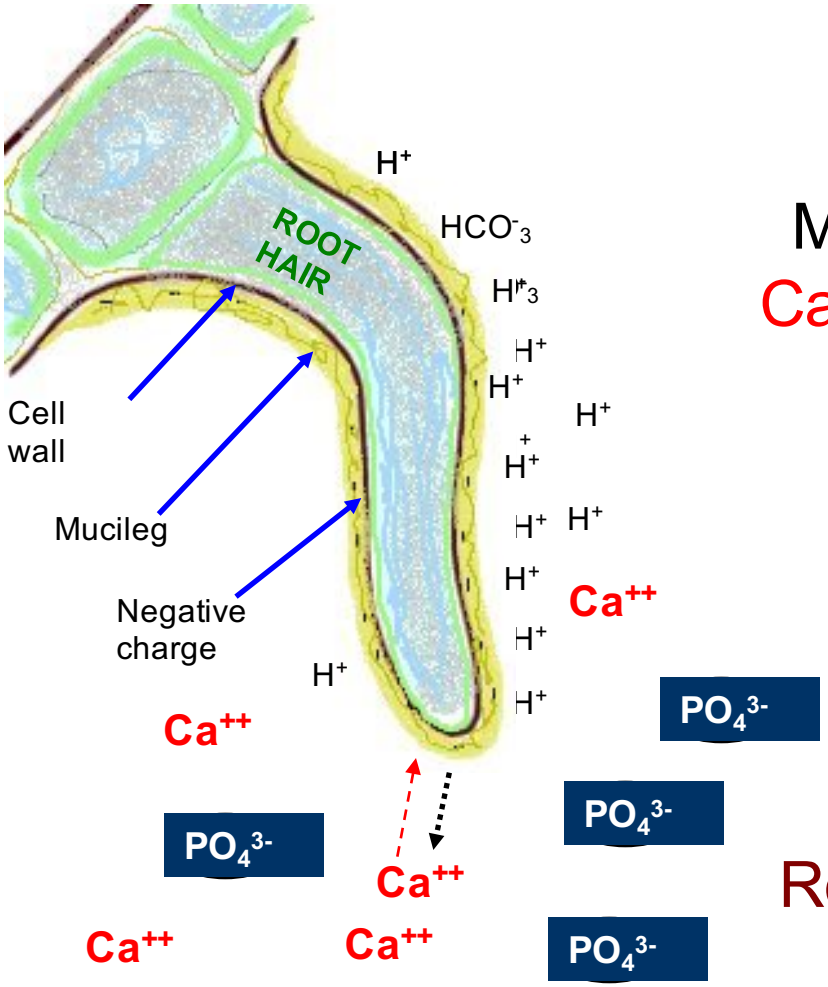
P and K move by diffusion due to chemical gradients

P moves ***very*** slowly.



Diffusion: movement from an area of high concentration to an area of low concentration

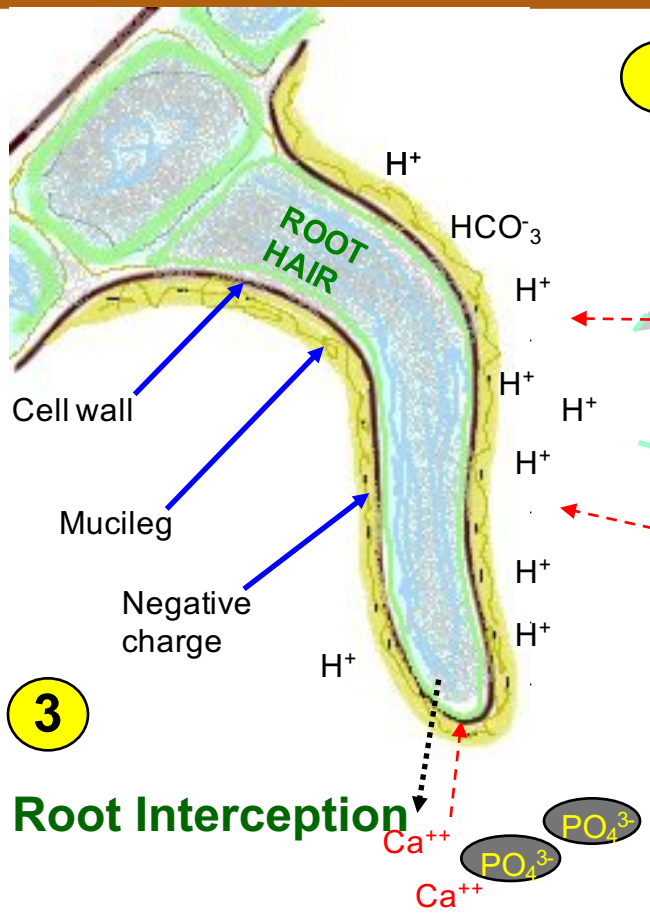
Root Interception



Most PO_4^{3-} and some Ca^{++} and micronutrients reach roots via interception

Root extension is essential

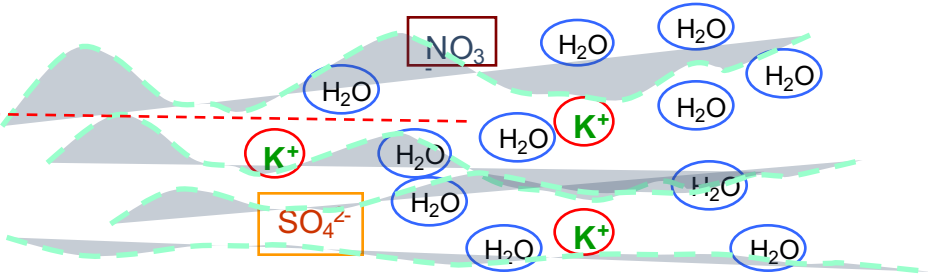
3 processes run simultaneously



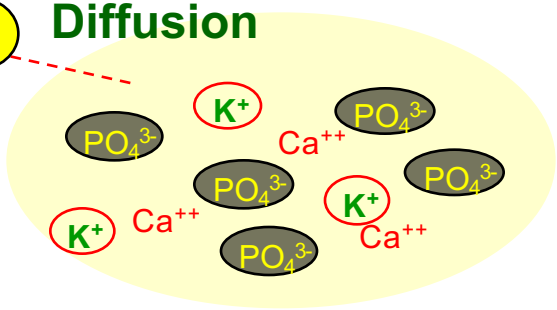
Root extension is necessary

1 Mass flow

Most NO_3^- and SO_4^{2-} move with water to the roots.



2 Diffusion



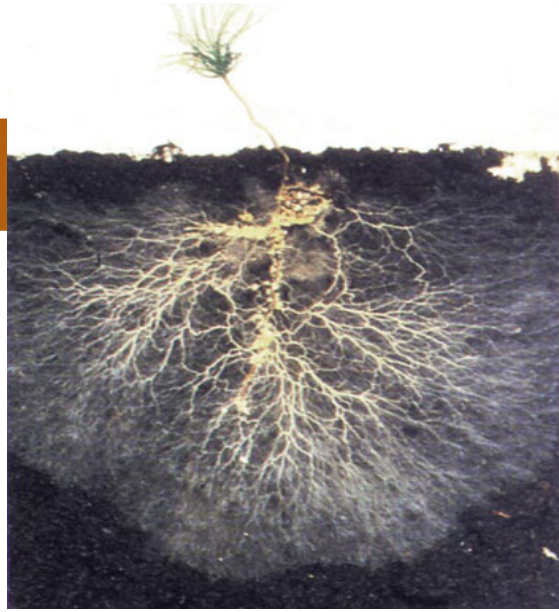
Most P and K move by process of diffusion due to chemical gradients.

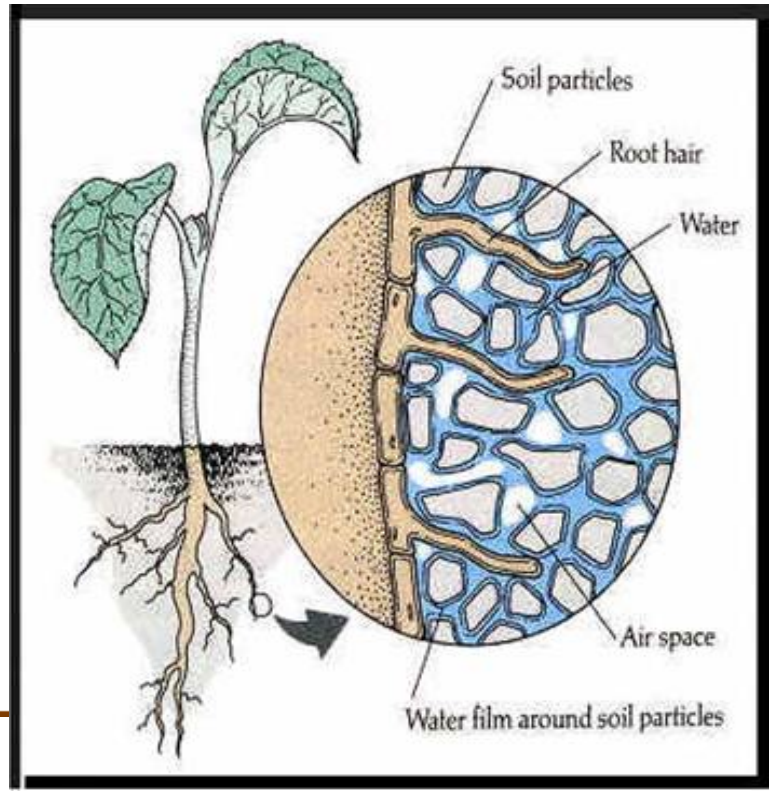
Nutrient mobility / movement

- **Inorganic Nitrogen**: highly mobile in soil: apply only some pre-plant (organic N is immobile)
- **Phosphorus**: highly immobile – apply most pre-plant, but…
- **Potassium**: held on clay or humus particles. Can apply the full crop requirement pre-plant ***or*** in stages in light soils.
- **Calcium** and **magnesium**: held on clay or humus particles
- **Sulphur**: highly mobile in soil (leaching)
- **Zn, Cu, Fe, Mn**: all immobile in soil (cations)
- **B** and **Mo**: mobile in soils (anions)

also refer to Fact Sheets

Importance of healthy roots

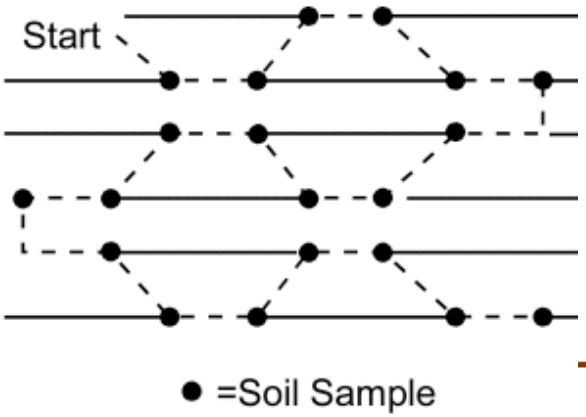




<u>The</u> factor determining nutrient uptake is root length density

Soil Sampling: Refer to fact sheet

- Sample 0-15cm and 15-30cm or 0-30cm depth or according to soil profile
- Take at least 20 sub samples and mix together
- Select 1 x 500g composite samples and send to lab ASAP
- Nutrient stratification – e.g. reduced tillage
- Sample for available NO_3 and NH_4: 0-30cm or 0-60cm



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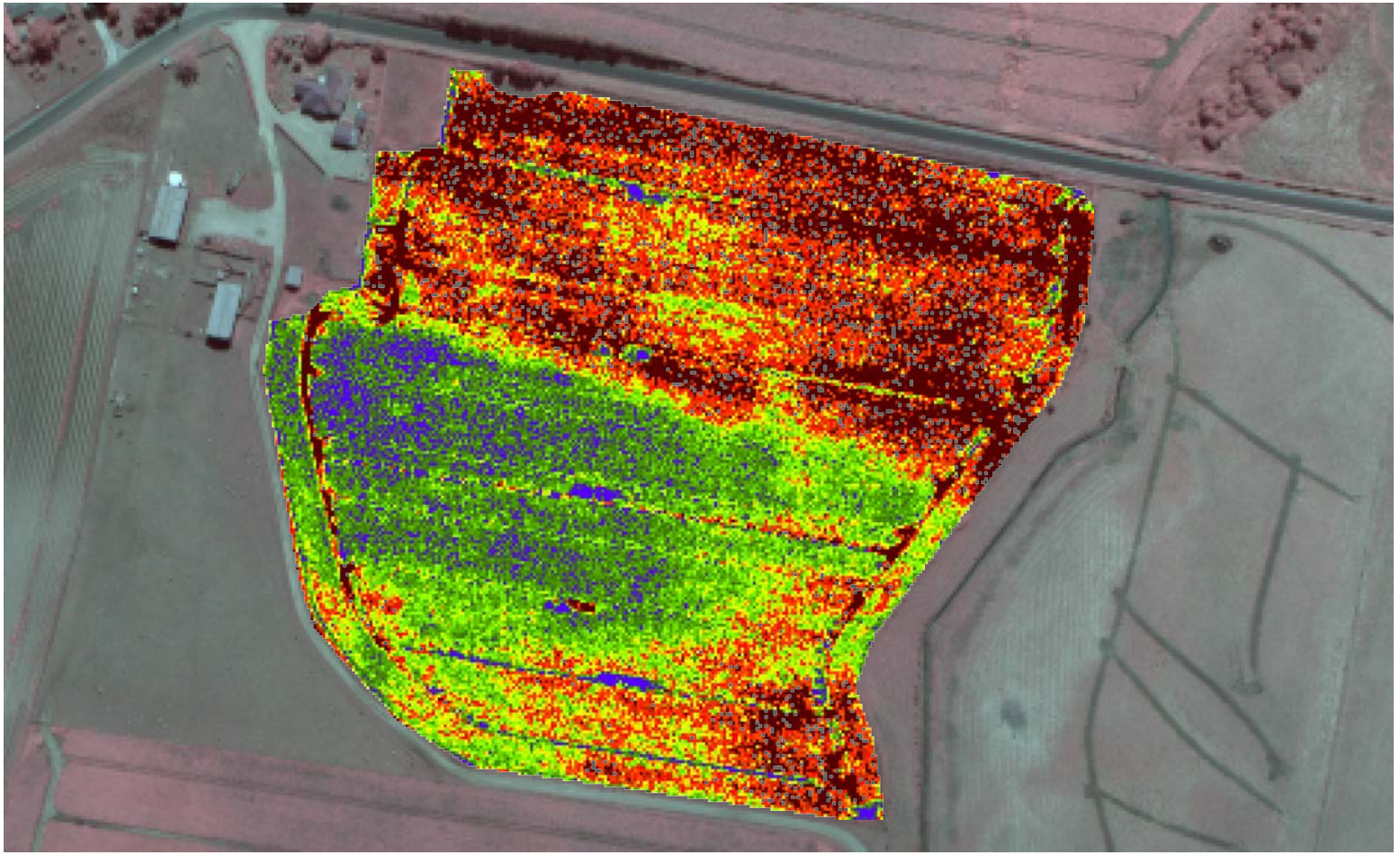
Consider within paddock variations

Aerial Crop Imaging 3 March 2015
Addison Hill

TERRAPIX .com.au



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Soil test interpretation fact sheet

Refer to the soil test interpretation fact sheet for a detailed and comprehensive explanation of how to ***read and interpret*** a soil test report.

Briefly…

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Soil test interpretation: desirable ranges

Nutrient		v. low	low	ideal	high
pH (in water)		5	5.5	6 - 7	8
pH (in $CaCl_2$)		4.5	5	5.5 - 7	7.5
Nitrate – N (topsoil)	ppm	<10	20	40 - 50	>60
Phosphorus (Colwell)	ppm	<20	30-60	70 - 100	>100
Phosphorus (Mehlich 3)	ppm	<20	20-40	40-80	>80
P Buffer Index (PBI)				<80	
Sulphur	ppm	2	5	10 - 20	15
Copper	ppm	<0.3	<2	2 - 20	>20
Zinc	ppm		<1	1 - 20	>20
Manganese	ppm		<5	10 - 50	>50(tox)
Iron	ppm		<10	10 - 200	>200
Boron	ppm	0.1	0.4	0.5 - 4	>5
Molybdenum	ppm	0.5	1	2	>2
Organic carbon	%	<0.6	1.1	2 – 2.3	>3
Conductivity ($EC_{1:5}$)	dS/m	< 0.15 dS/m (depends on soil and crop)			
Chloride	ppm	50	100	<200	>200

Colwell P and K levels are for medium textured soils

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Soil test desirable ranges guide – Cations

Plant uptake of calcium, magnesium and potassium in strongly influenced by their proportions in the soil. ***Imbalances can cause plant deficiencies.***

Aim: Potassium 5%, Calcium:magnesium ratio = 3-5:1

Nutrient		v. low	low	good	high
Ca/Mg Ratio		<2	3	3-5	>5
Potassium	meq/100g	0.2	0.3	0.5-0.7	1
Potassium	% of cations	<1	3	5	>8
Calcium	% of cations	50	65	75	>80
Magnesium	% of cations	<5	<10	10-20	>20
Sodium**	% of cations	<1	<3	<4	>6
Aluminum**	% of cations	<0.1	<0.5	<1	>1

* For sodium and aluminium, the lower the better

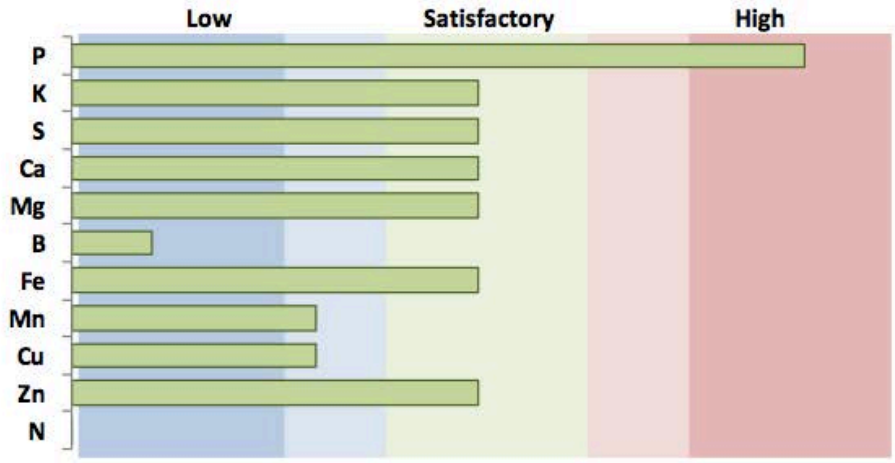
expressSoil Results

Analyte	Units	Result	Optimal Range	Status
pH (H_2O)	(pH)	**6.66**	6 - 7	Neutral
pH ($CaCl_2$)	(pH)	**6.04**	5.3 - 6.5	Neutral
EC	dS/m	**0.11**	0 - 0.15	Satisfactory
Lime requirement	t/ha			
ESI	units	**0.062**		High
Total Carbon	%	**5.291**		
Total Nitrogen	%	**0.341**		
Carbon:Nitrogen Ratio	(ratio)	**15.504**		
Organic Matter	%	**8.1**		Very High
M3 PSR	(ratio)	**0.10**	0.06 - 0.23	Satisfactory
Phosphorus	ppm	**166.60**	40 - 90	Very High
Potassium	ppm	**265.91**	245 - 400	Satisfactory
Sulphur	ppm	**17.2**	12 - 45	Satisfactory
Calcium	ppm	**2358.23**	1620 - 2700	Satisfactory
Magnesium	ppm	**208.51**	200 - 400	Satisfactory
Sodium	ppm	**65.85**	20 - 85	Satisfactory
Chloride	ppm	**20.95**	0 - 200	Satisfactory
Zinc	ppm	**4.81**	2.2 - 11	Satisfactory
Copper	ppm	**2.32**	2.5 - 10	Low
Boron	ppm	**0.69**	2.2 - 6	Very Low
Manganese	ppm	**10.5**	18 - 70	Low
Iron	ppm	**74.132**	35 - 230	Satisfactory
CECe	meq/100g	**17**		
Calcium	meq/100g	**11.8 (69.4%CEC)**	8.1 - 13.5	Satisfactory
Potassium	meq/100g	**0.7 (4.1%CEC)**	0.6 - 1.0	Satisfactory
Magnesium	meq/100g	**1.7 (10.0%CEC)**	1.7 - 3.3	Satisfactory
Sodium	meq/100g	**0.3 (1.8%CEC)**	0.1 - 0.4	Satisfactory
Base Saturation	%	**85.3**	80 - 87	Satisfactory
Exchangeable Acidity	meq/100g	**2.5 (14.7%CEC)**	13 - 20 %CEC	Satisfactory
Aluminium Saturation	%	**0.00**		
Ca:Mg Ratio	(ratio)	**6.94**	3 - 5	Very High
K:Mg Ratio	(ratio)	**0.4**	0.3 - 0.5	Satisfactory
Active Carbon	ppm	**365.0**		
WSA	%	**14.9**		

Nutrient Status and Imbalances:

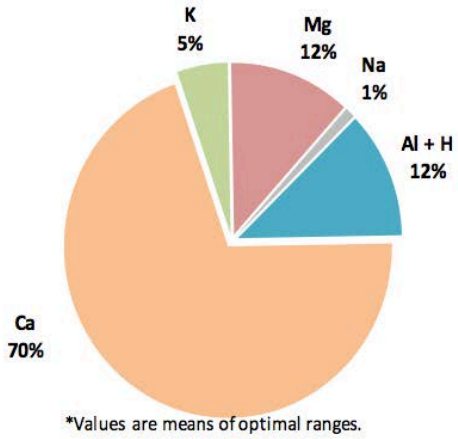
CABENRE 0-15CM (Sampled: 11/06/2015)

	Desired Level (kg/ha)	Measured Level (kg/ha)
Phosphorus	24.6	63.0
Potassium	113.4	100.5
Sulphur	10.77	6.50
Calcium	816.5	891.4
Magnesium	113.4	78.8
Boron	1.5	0.3
Iron	50.09	28.02
Manganese	16.6	4.0
Copper	2.4	0.9
Zinc	2.5	1.8
Nitrogen		20.10



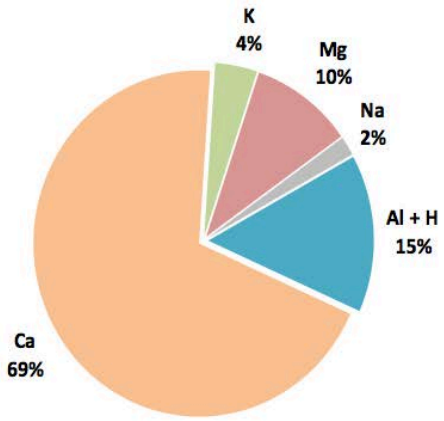
Soil Cation Composition (as % CECe)

Desirable Levels



*Values are means of optimal ranges.

Measured Levels



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Develop a fertiliser program

1. Determine the crop nutrient requirement (kg/ha)
   - ***Soil test***: deficiencies and imbalances
   - ***Crop removal***: recommendations
   - ***Experience***: previous crops and soil tests
2. Fertiliser program considerations:
   - Soil texture, organic carbon, rotations
   - Mobility / movement of different nutrients, nutrient interactions
   - Crop requirements at different growth stages
   - Available application methods and fertilisers
3. Monitor crop using ***leaf/sap testing***
4. ***More on this in another Webinar!***

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Nutrient removal: kg nutrient /tonne crop

Crop	N	P	K	S	Ca	Mg
Bean green	4.0	0.9	3.0	0.0	0.4	0.3
Broccoli	4.5	0.9	4.6	0.0	0.4	0.2
Cabbage Dutch	3.0	0.4	2.7	0.0	0.6	0.2
Capsicum	3.0	0.3	2.9	0.0	0.1	0.2
Carrot	2.0	0.4	3.7	0.0	0.6	0.5
Cauliflower	4.0	0.5	3.3	0.0	0.4	0.2
Celery	3.5	0.9	6.6	0.0	1.9	0.3
Cucumber	1.0	0.4	1.5			
Lettuce	3.0	0.4	3.3	0.0	0.7	0.2
Lettuce oakleaf	2.5	0.3	3.2	0.0	0.6	0.2
Pea green	5.0	0.7	3.3	0.0	0.6	0.4
Pumpkin	1.8	0.4	2.5	0.0	0.4	0.2
Spinach	4.2	0.6	0.6	0.0	1.3	0.6
Sweetcorn	4.0	0.9	4.4	0.0	0.1	0.4

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Summary

- Good sampling
- Nutrient levels in desireable range
- Consider factors affecting nutrient uptake by crops:
  - Healthy roots
  - Irrigation management
  - Weather conditions
  - Crop stress
- Nutrient interactions
- Nutrient movement in soils
- Nutrient removal by crops

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Thank You

Doris Blaesing, dorisb@rmcg.com.au

Gordon Rogers, gordon@ahr.com.au

Join us for the next webinar on plant analysis interpretation!

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