Nutrient Management in Horticulture

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Growcom is pleased to acknowledge and thank our funders and project partners in the delivery of the Caring for our Country Reef Rescue program

CARING FOR OUR COUNTRY

NQ Dry Tropics
LAND & WATER SOLUTIONS

Burnett Mary Regional Group

FITZROY BASIN ASSOCIATION

Nutrient Management Workshop

- Sampling & Laboratory Analysis
- Soil Interpretation
  - pH + EC + OC
  - Cations
  - N + P + S
  - Micronutrients
- Plant Tissue Interpretation

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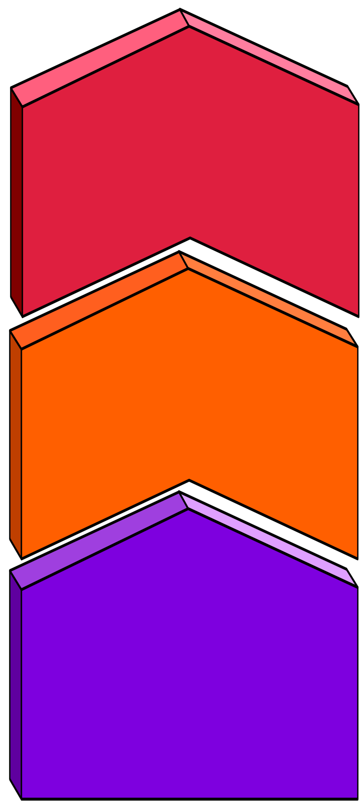
We wish to acknowledge the assistance provided by Garry Kuhn for this presentation

Incitec Pivot

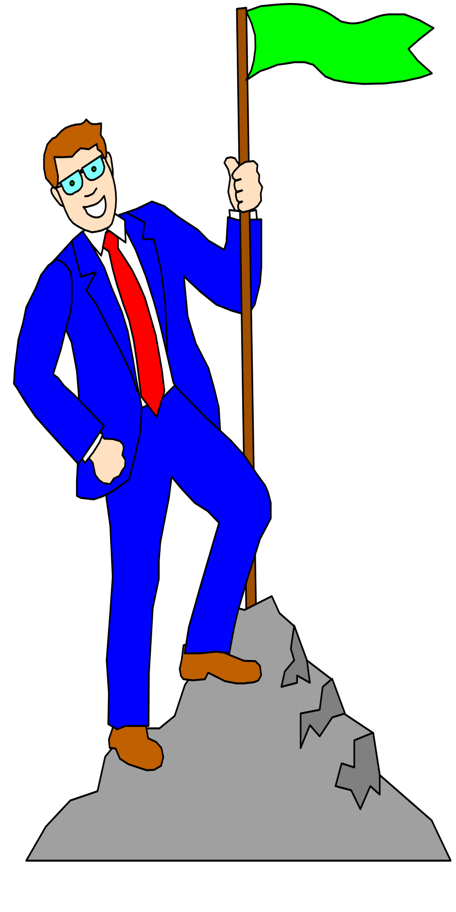
WHAT ARE THE THREE STEPS IN SOIL PLANT TISSUE & WATER ANALYSIS ?

THE THREE STEPS

- **SAMPLING**
- **ANALYSIS**
- **INTERPRETATION**



All are important



Nutrient Management

Sampling

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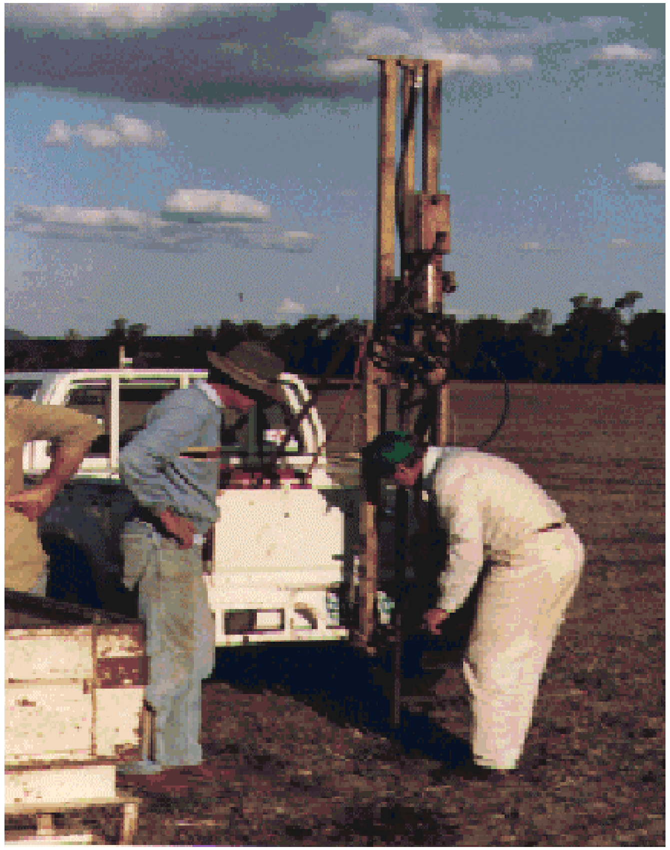

Sampling Time?

- Soil amendments
  - early in the fallow period;
- Basal fertilizer
  - a few weeks before planting;

Sample Storage

KEEP SAMPLES COOL, OR DRY.

- in field - esky with cooler bricks

- short term (24 - 48 hours) - cool to about 4^{o}C

- long term (48 hours - months) - dry
  - freeze

Plant Tissue

Sampling

- Correct
  - ➢ plant part
  - ➢ growth stage or time of year
- Mobile elements (e.g. nitrate nitrogen)
  - ➢ sample at the same time each day
    - i.e. before 10 AM
- Same variety/ rootstock/ planting
- Avoid damaged, dusty or contaminated leaves and physiologically stressed plants

Handling and Storage

- Clean hands
- Wash off any soil adhering to sample
- Dry (air, thermal or microwave oven)
- Place in clean paper bags, not plastic
- Send to laboratory
    - by express courier service ASAP

Problem Solving

Take whatever samples are necessary:

Soil (shallow and/or deep),

Plant tissue,

and Water,

from Good and Poor Areas.

Nutrient Management

Laboratory Analysis

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SOME HISTORY

- BSES was the first organisation to offer a soil testing service to growers in Australia in the 1930s.

Laboratory

Quality Assured

Incitec Pivot is a member of ASPAC (Australasian Soil & Plant Analysis Council), and the laboratory is registered with NATA.

Soil Analysis

- plant available nutrients (soluble and exchangeable), not total.

- Other measurements
  - texture, colour, slaking, pH, electrical conductivity and organic carbon.

- Procedure

dry → grinding → extraction → measurement

Plant Tissue Analysis

- For total nutrient content

  dry → grind → digestion → measure

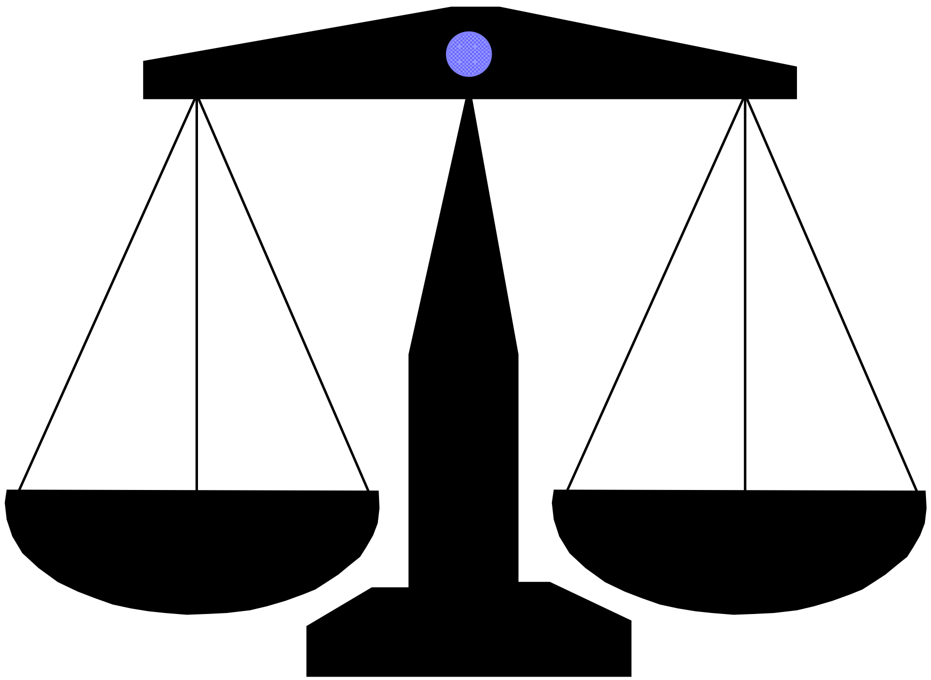
- Results are expressed on a dry weight basis

METHODS

- **Wet Chemistry**
  - **Dried Samples (w/w)**
  - **Sap (w/v)**

- **Non-Destructive**
  - **NIR**

Units of Measurement



%	=	per cent parts per 100
mg/kg	=	mg/1 000 g mg/1 000 000 mg parts per million (ppm)

To convert from % to mg/kg, multiply by 10 000.

Units of Measurement

- Soil
  - meq/100g
  - mg/kg
- Plant Tissue
  - % macronutrients
  - mg/kg micronutrients

MEASURE	UNIT	SYMBOL
Length	metre	m
Volume	litre	L
Mass	gram	g
Conductance	sieman	S

PREFIX	FACTOR		SYMBOL
micro	10^{-6}	1 millionth	μ
milli	10^{-3}	1 thousandth	m
centi	10^{-2}	1 hundredth	c
deci	10^{-1}	1 tenth	d
Deca	10^{1}	10 times	D
hect	10^{2}	100 times	h
kilo	10^{3}	1 000 times	k
Mega	10^{6}	1000 000 times	M

Converting meq/100g to ppm

	Multiplied by this number to convert to ppm
Ca meq/100g	200
K meq/100g	391
Na meq/100g	230
Mg meq/100g	121

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Soil Interpretation

pH + OM + EC

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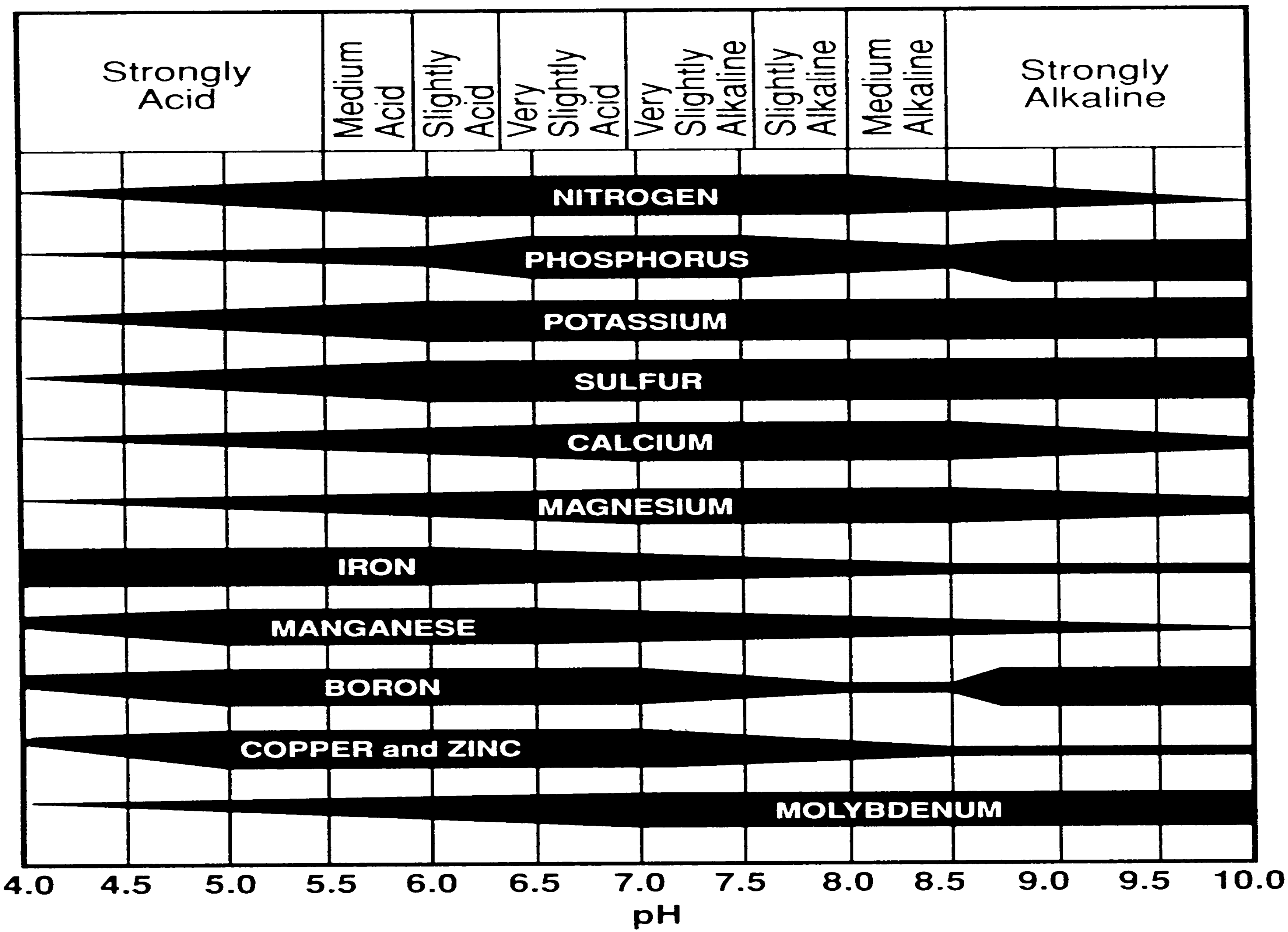
pH

- **pH_W 1:5 Soil:Water Suspension**
- **pH_{CaCl} 0.1 M $CaCl_2$ Solution**

The pH_w Scale

- Less than 7 is acid
- Above 7 is alkaline
- Optimum pH_w for most plants is 6.0 - 7.5



Strongly Acid
Medium Acid
Slightly Acid
Very Slightly Acid
Very Slightly Alkaline
Slightly Alkaline
Medium Alkaline
Strongly Alkaline
NITROGEN
PHOSPHORUS
POTASSIUM
SULFUR
CALCIUM
MAGNESIUM
IRON
MANGANESE
BORON
COPPER and ZINC
MOLYBDENUM
4.0
4.5
5.0
5.5
6.0
6.5
7.0
7.5
8.0
8.5
9.0
9.5
10.0
pH

Crops vary in their tolerance of soil acidity and aluminium

- **Sugarcane**
  - will grow in acid soils
  - provided calcium is adequate (as a nutrient)

- **French Beans**
  - are intolerant of soil acidity

Soil acidification occurs

naturally in productive

agricultural systems

Soil acidification can be caused by:

- Use of nitrogen fertilisers
- Nitrogen fixation by legumes
- Cultivation and mineralisation of soil organic matter
- Loss or removal of bases by leaching and in farm produce

Buffer pH

Liming Estimate

(Test validated in Queensland only)

ORGANIC CARBON

- Most Australian soils contain < 5 % OC,

  Cultivated soils typically < 2 % OC;

- Organic Carbon x 1.8 = Organic Matter

Soils fertility is typically higher in soils high in organic matter!

“Black as Coal”

SOILS HIGH IN ORGANIC MATTER HAVE A DARK COLOUR.

SALINITY

- A measure of the amount of soluble salts in the soil
- Salt affects plant growth

$EC_{1:5}$ is a measure of the **quantity** of salt in the **soil**;

EC_{SE} is measure of the **salt concentration** in the **soil water**.

Nutrient Management
Soil Interpretation

<u>Cations</u>

Calcium - Ca
Magnesium - Mg
Sodium - Na
Potassium - K

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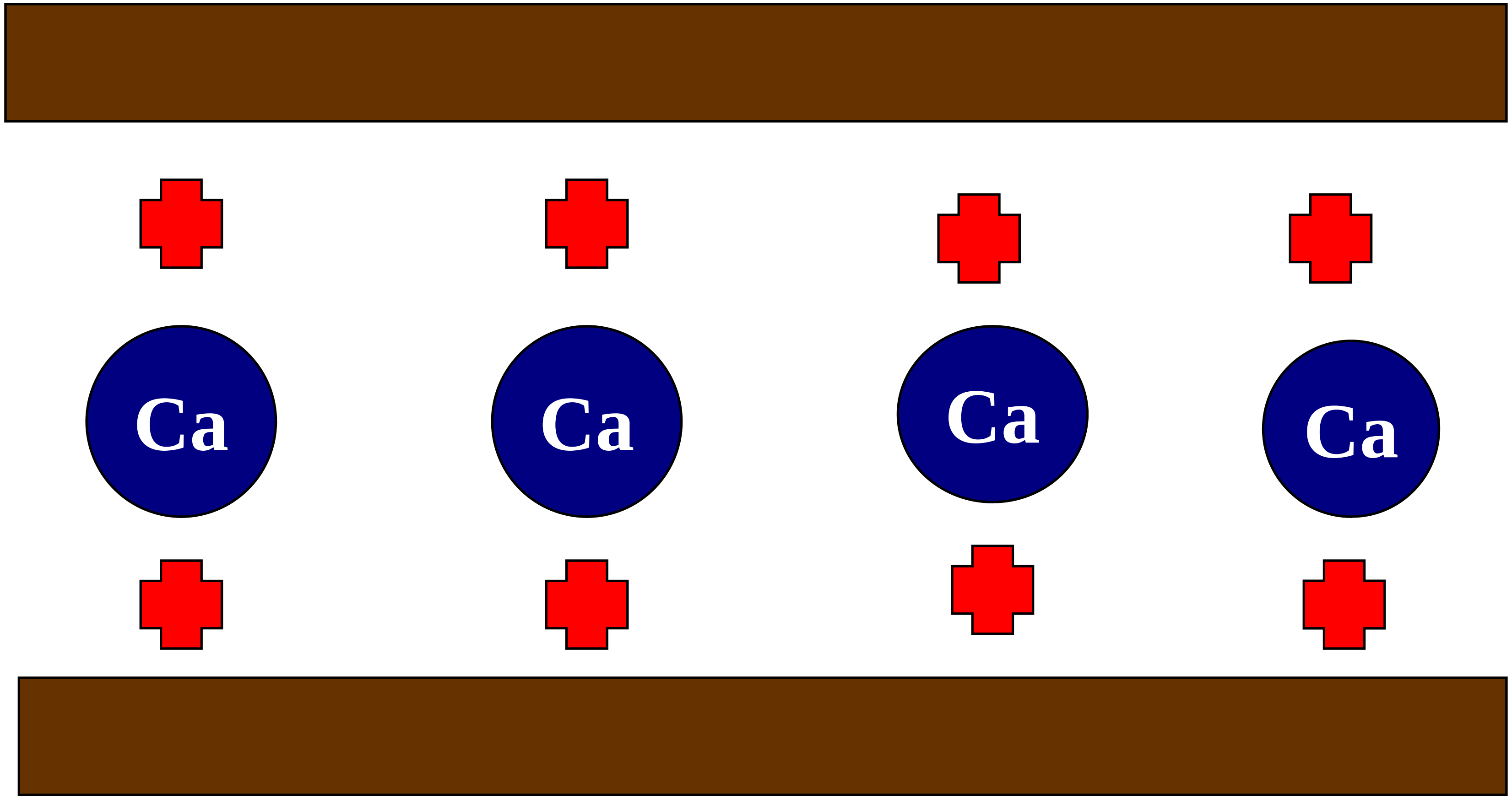
CATIONS

- Positively (+) charged ions
  - Potassium K^+
  - Calcium Ca^{2+}
  - Magnesium Mg^{2+}
  - Sodium Na^+
  - Aluminium Al^{3+}

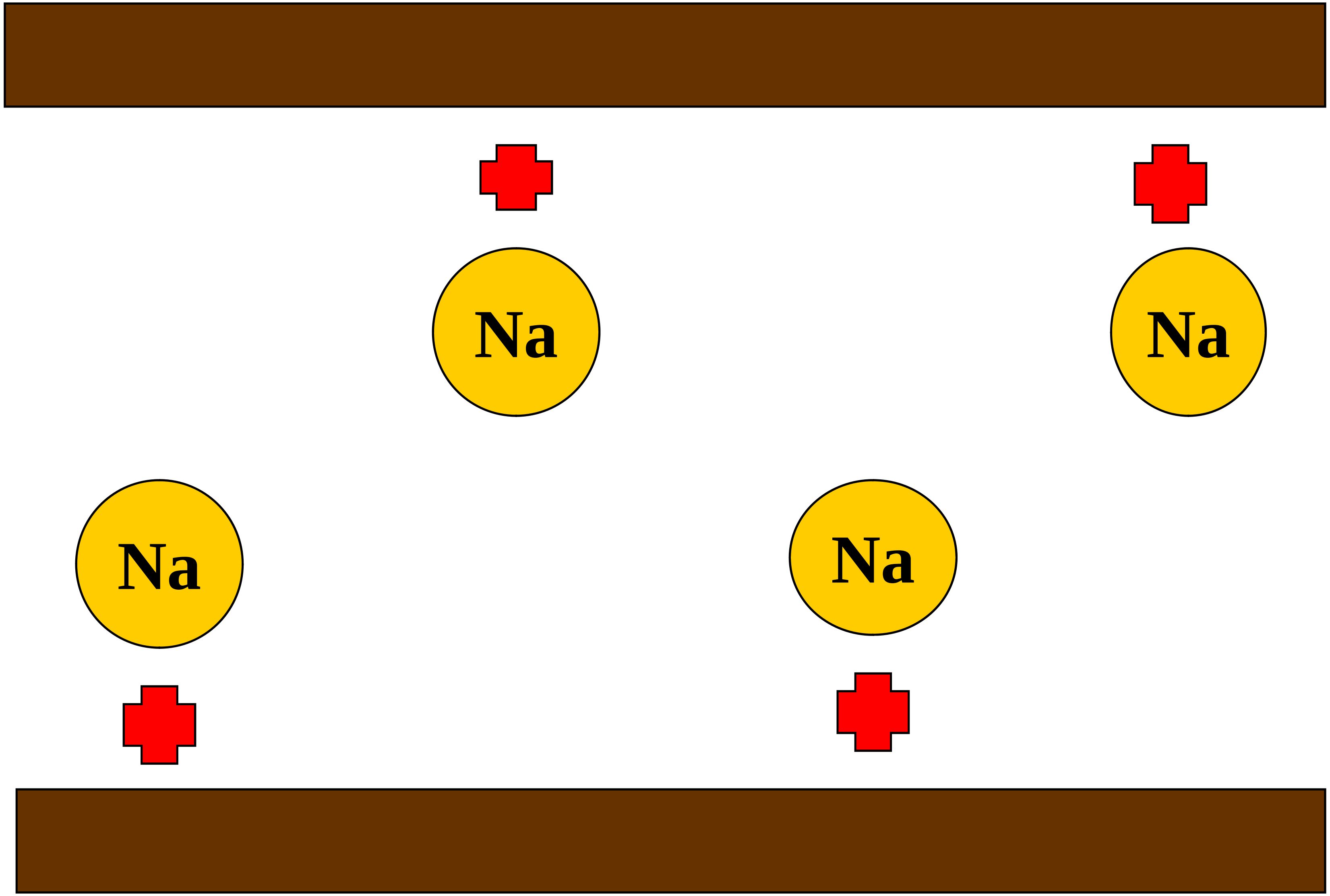
Cation Exchange Capacity

Texture	meq/100 g
SAND	2 - 3
SANDY LOAM	2 - 12
LOAM	5 - 20
CLAY	10 - 80
ORGANIC MATTER	> 100

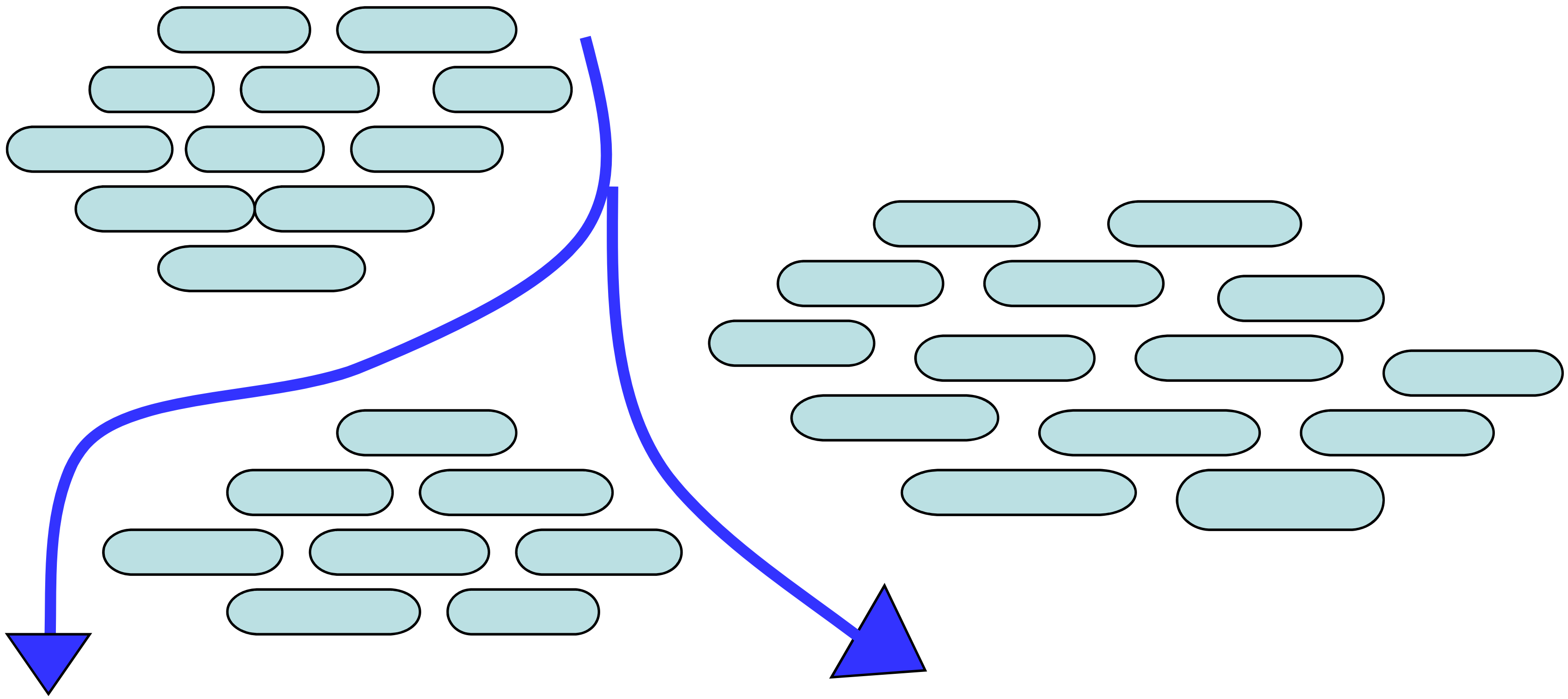
Divalent cations such as calcium hold clay platelets together



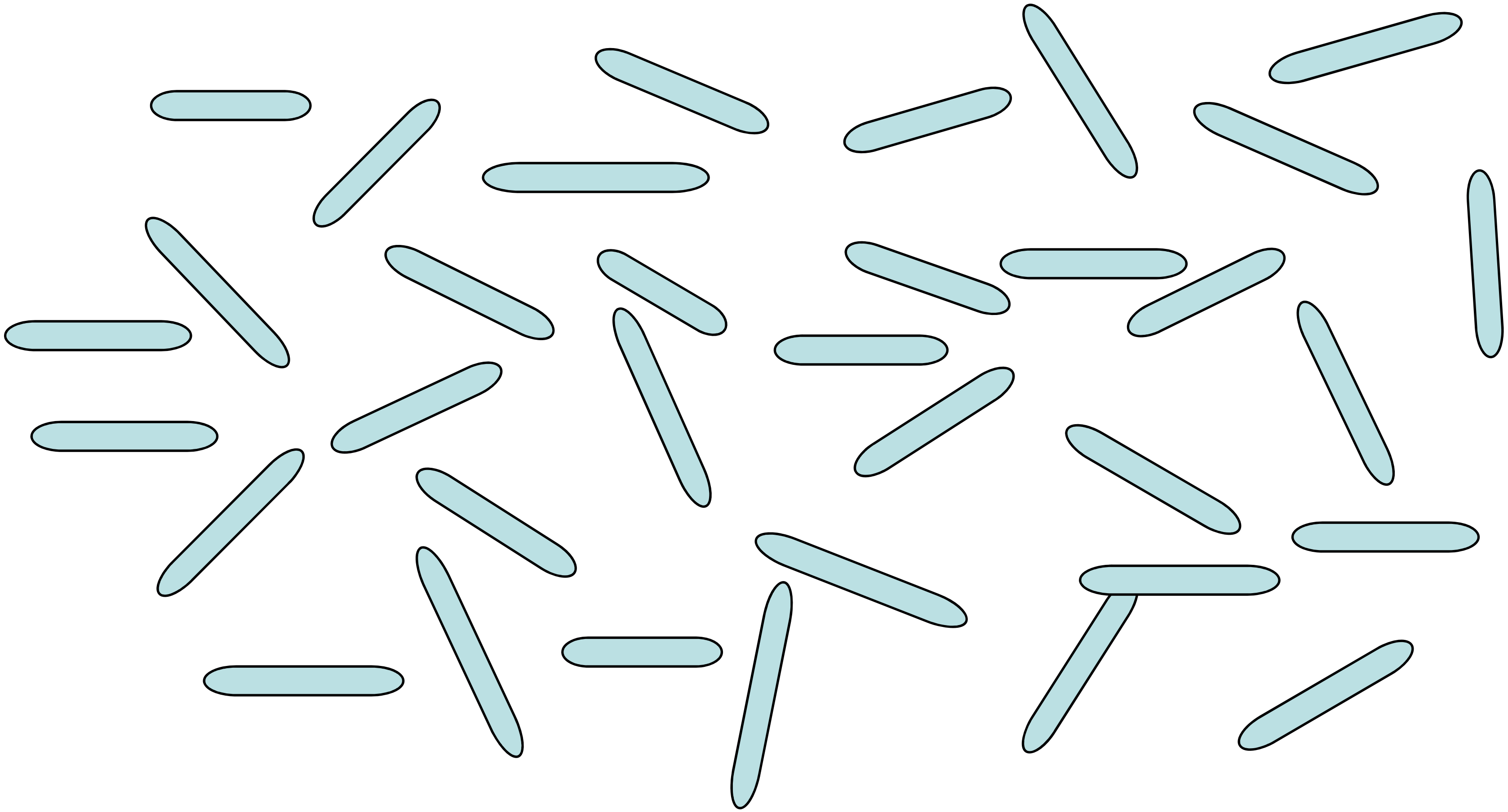
Monovalent cations such as sodium do not!



Soils dominated by calcium form aggregates (crumbs or peds). Such soils are described as self-mulching, and have good internal drainage.



The clay platelets in soils dominated by sodium remain dispersed as the soil dries. The soil is impervious, crusts and sets hard, and forms large clods when cultivated.



THE “IDEAL” SOIL!

CATION	%
Calcium	65 - 80
Magnesium	10 - 15
Potassium	1 - 5
Sodium	< 5
Aluminium	< 2

SODICITY

- Sodium status of the soil
- Affects soil structure

Exchangeable Sodium Percentage

ESP or % Na

Generally:-

- **ESP < 5 non - to slightly sodic**
- **ESP 5 - 15 sodic**
- **ESP > 15 strongly sodic**

Calcium and Magnesium

are most likely to be low

on light textured sandy soils

in high rainfall areas!

Ca : Mg Ratio

- Usually in the range of 2.5 to 5 : 1
- < 2.5 : 1 indicates magnesium is proportionately high
  - Soil structure may be affected
  - May need gypsum
- If the ratio is high, fertiliser magnesium may be required if soil magnesium is low.

Lime or Gypsum?

- Lime is used on acid soils
  - to raise the pH.

- Gypsum is used on sodic soils
  - to improve structure.

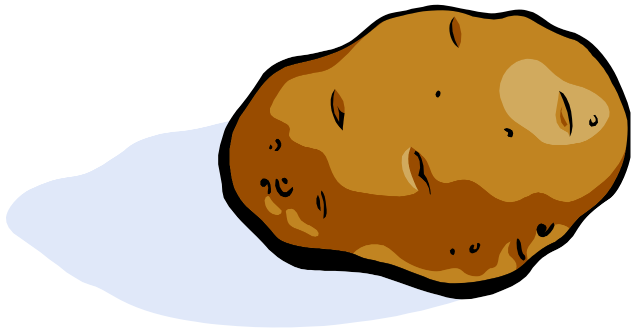
DOLOMITE

Used as an alternative to lime on acid soils where magnesium is required as well as calcium.

Depending on their rates of application,
the use of fertilisers such as Cal-Am and
Superphosphate may supply sufficient calcium to meet
crop requirements.

Product	%N	%P	%S	%Ca
Cal-Am	28			8
Triple Super		20.7	1	15
SuPerfect Super		8.8	11	20

For example:

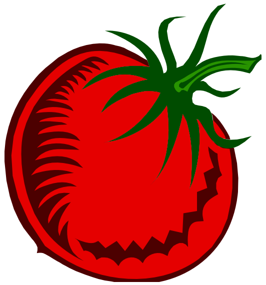


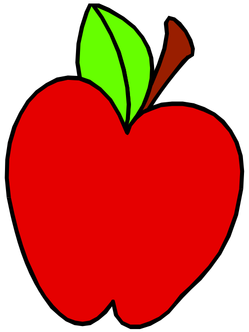
Responses to lime are not obtained where planting fertilisers based on superphosphate are used at high phosphorus rates, e.g. Incitec Pivot Q5 at 2 500 kg/ha in potatoes on red volcanic soils on the Atherton Tablelands in north Queensland.

Q5 5.3% N - 5.8% P - 5.0% K - 13.3% S - 12.8% Ca

Calcium Deficiency in Fruit & Veg

e.g. Blossom End Rot





- Calcium is immobile in plants
  - symptoms of deficiency most commonly occur at the growing points;

- May be induced by moisture stress,
  even on soils well endowed with calcium

Calcium Nitrate

- 15.5% N, 19% Ca
- Soluble calcium fertiliser
  - fertigation programs
  - non-acidifying nitrogen fertiliser.

Foliar Calcium Sprays

- Calcium is immobile in plants
- Regular sprays are required during critical growth stages, e.g. fruit fill
  - May need to be applied weekly, perhaps more often
  - Direct the spray at the fruit

Insoluble Magnesium Fertilisers

- Magnesite
  - $MgCO_3$
- Dolomite
  - $CaMg(CO_3)_2$
- Magnesium Oxide (Granomag AL7)
  - MgO

•Apply several months ahead of planting, e.g. at start of fallow period.

•Are likely to be ineffective on neutral to alkaline soils.

Magnesium Fertilisers

with magnesium in the water soluble sulfate form

- Potassium Magnesium Sulfate
  - Sul-Po-Mag
  - K-Mag
- Magnesium Sulfate
  - Monohydrate - Kieserite
  - Heptahydrate - Epsom Salts (Liquifert Mag)

Use where a quick response to magnesium is required; & on calcareous (high pH) soils.

Potassium Magnesium Sulfate

- A granular fertiliser
  - for dry application to the soil.
  - May be used in planting fertilisers to supply starter magnesium, to supplement that applied pre-plant, e.g. as Dolomite or Granomag AL7.
- Granules dissolve too slowly in water to use in fertigation programs and foliar sprays

Liquifert Mag

- A soluble fine crystalline product, for application in solution:
  - Fertigation,
  - Foliar sprays;
- Unsuitable for use in blends with granular fertilisers, or dry application by machine.

Responses to Potassium

Are most likely to occur on light textured sandy soils

(with low reserves of potassium).

Leaching

Potassium is less subject to leaching than nitrate nitrogen, but is more readily leached than phosphorus.

Potassium in Plants

Taken up in larger quantities than any other nutrient except nitrogen.

Potassium depletion in soils is most evident where all or most of the above ground plant parts are harvested, e.g. sugarcane, hay and silage.

EFFECTS ATTRIBUTABLE TO LOW SOIL POTASSIUM

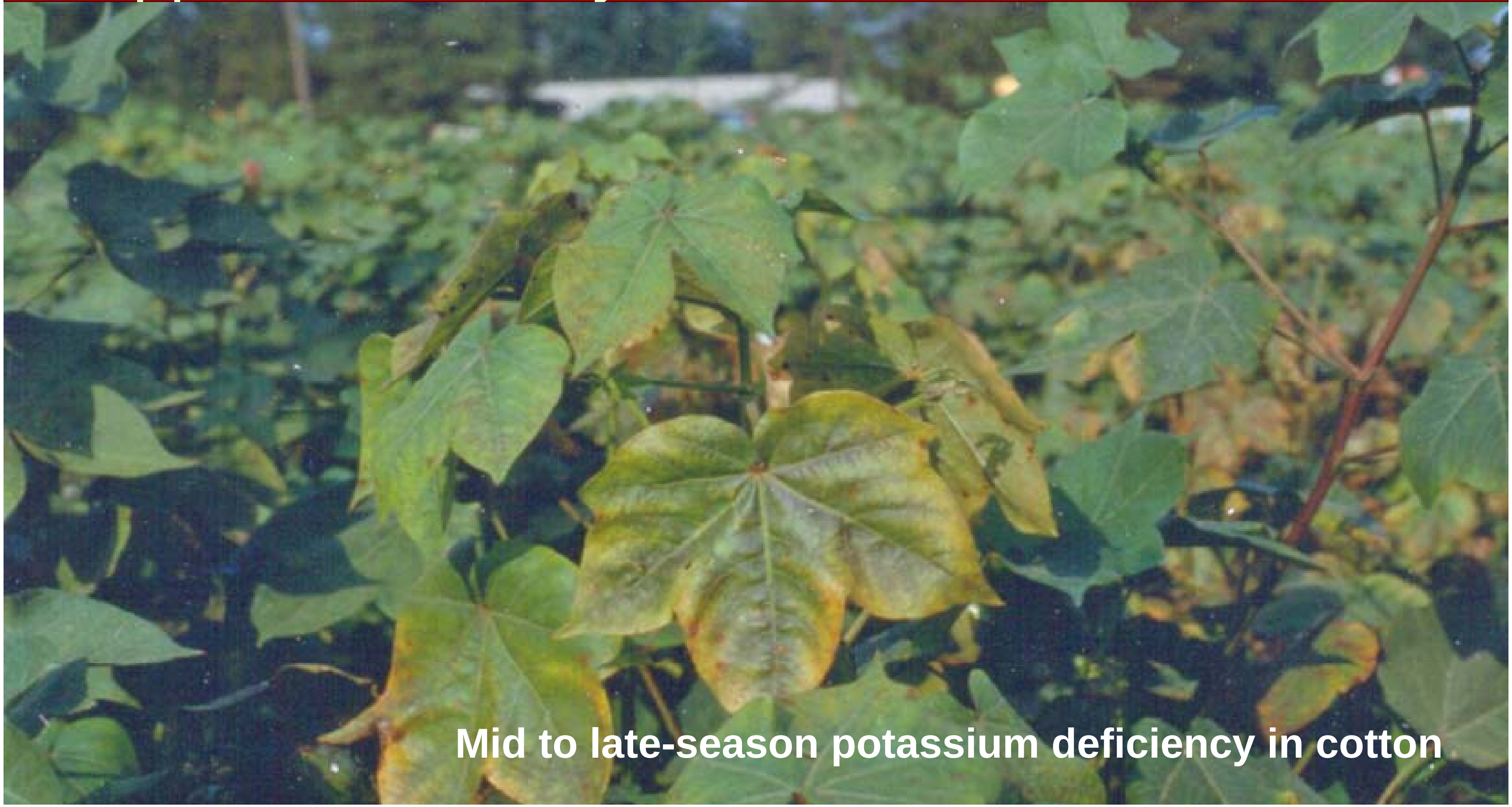
- Reduced yields and quality
- Loss of legumes from mixed pastures:-

  - inability of tap-rooted legumes to compete with the finer root system of grasses,

  - poor seed set
- Increased lodging
- Increased susceptibility to disease

Potassium is very mobile in plants.

Deficiency symptoms, e.g. leaf scorch, first appear in recently matured and older leaves.



Mid to late-season potassium deficiency in cotton

Potassium is not a component of any organic compound

- Readily leached from plant material
  - e.g. from trash

POTASSIUM FERTILISERS

CHEMICAL NAME	PRODUCT	% N	% K	% S
Potassium Chloride	Muriate of Potash		50	
	Liquifert K*			
Potassium Sulfate	Sulfate of Potash		41	18
	Liquifert K Spray*		42	
Potassium Nitrate	Prilled Potassium Nitrate	13	38.3	
	Liquifert K Nitrate*			

** Soluble Grades - for application in solution.*

Product Choice?

	Muriate of Potash	Sulfate of Potash	Potassium Nitrate
Price	⬋		
Low Chloride		⬋	⬋
Low Salt Index		⬋	
Solubility	⬋		⬋

When to apply potassium?

Applying too much potassium

in a single application

can result in inefficient plant use

(luxury uptake, leaching, fixation).

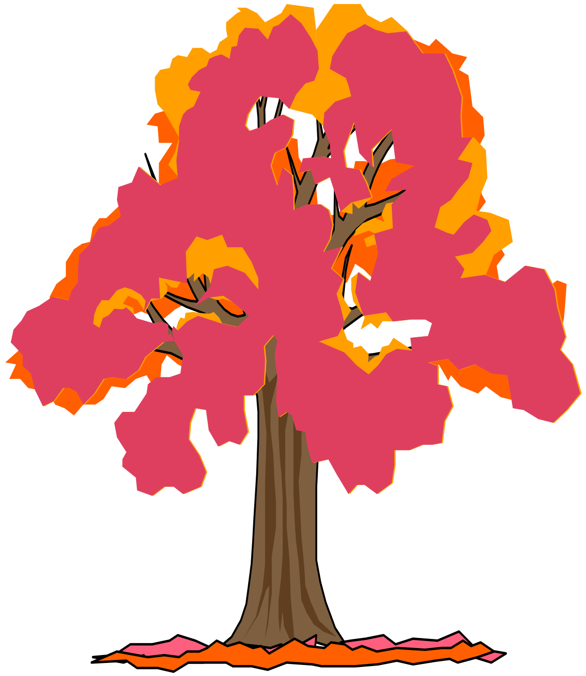
Annual Crops

- On heavy clay soils
  - applied pre-plant.
- If low rates are required
  - can be applied at planting
  - banded 5 cm to the side of and 5 cm below the seed
- Split applications may be necessary for high rates
- On sandy soils in high rainfall areas, side-dressings during the growing season will minimise leaching losses.

In tree, vine and plantation crops

Apply with nitrogen

as a NPK fertiliser.



Nutrient Management

Nitrogen

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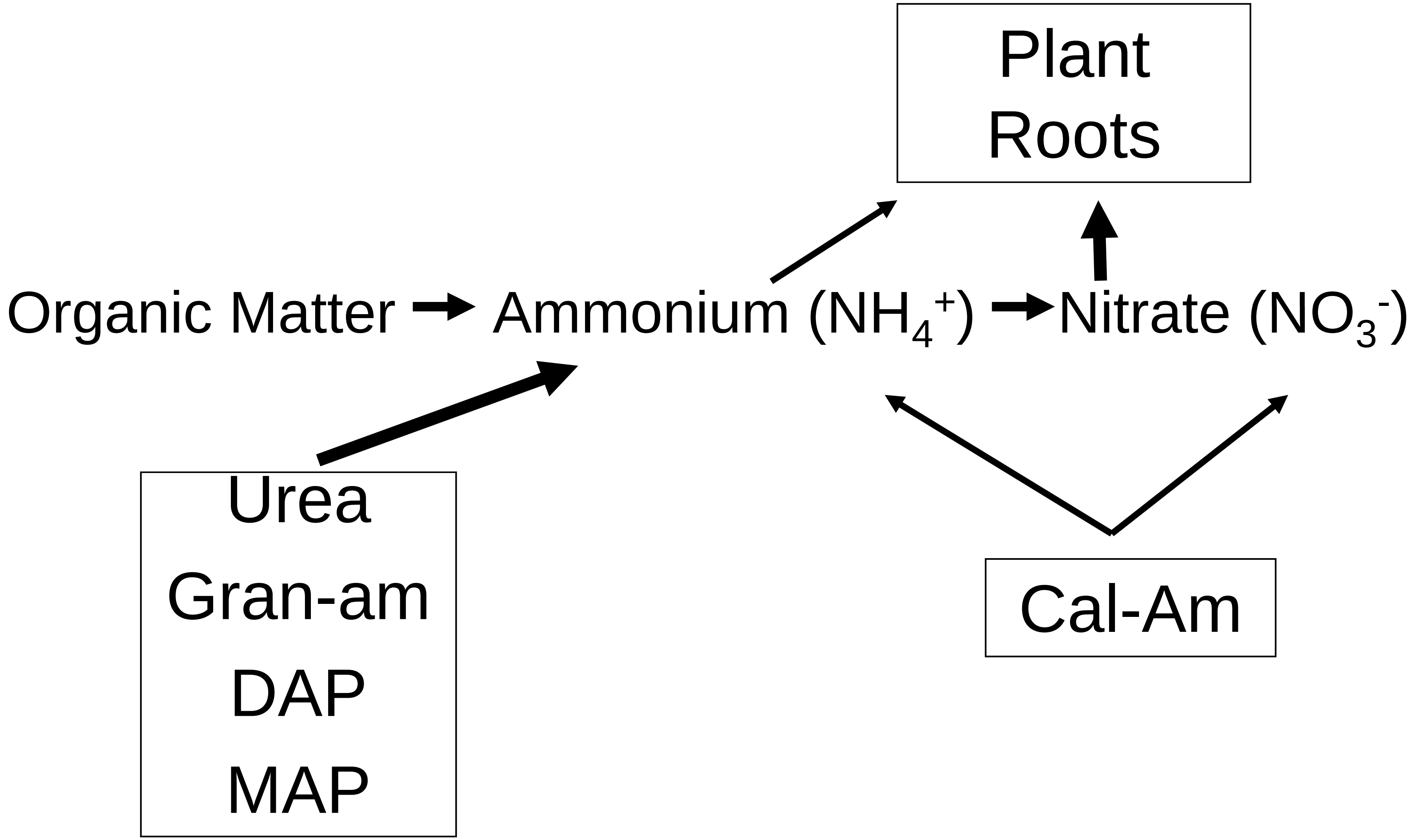
Soil Nitrogen

- Nearly all originates from the atmosphere
    - Parent rocks do not contain nitrogen
- Most is contained in the soil organic matter
- It is the only nutrient plants derive from the soil that exists as a gas (N_2) in its natural state
- All the other nutrients are derived from the parent rocks and minerals from which the soil was formed

Nitrogen Transformations in the Soil



Nitrogen Transformations in the Soil

Plant Roots

Organic Matter → Ammonium (NH_4^+) → Nitrate (NO_3^-)

Most plants have a preference for nitrate.

Nitrogen in Plants

- A constituent of chlorophyll and protein.
  - Deficient plants are:
    - Pale green to yellow (particularly the older leaves)
    - Stunted
    - Low yields
    - Low in protein

Nitrogen Losses

SOIL

- Immobilisation

WATER

- Surface run-off & erosion
- Leaching

AIR

- Volatilisation
- Denitrification
- Fire

Immobilisation

- Occurs when organic matter with a low nitrogen content (high C:N ratio), e.g. cereal stubble, decomposes;
- Soil microbes compete with plant roots for available soil nitrogen.

Leaching

- The loss of nitrate nitrogen (NO_3^-) below the root zone after heavy rainfall or irrigation
  - Organic and ammonium (NH_4^+) nitrogen are not subject to leaching. Ammonium ions are tightly sorbed onto soil colloids, i.e. clay and organic particles;
- Most likely to occur on freely-drained soils, e.g. sands.

Denitrification

- Occurs in water-logged soils;
- Micro-organisms, deprived of oxygen (O_2), reduce nitrate (NO_3^-) to nitrous oxides (NO_2 , NO) or nitrogen (N_2), which are lost as gases.

MINIMISING LEACHING & DENITRIFICATION LOSSES IN ANNUAL CROPS.

- Do not apply nitrogen pre-plant where
  - soil type, topography or climate predispose to water-logging or leaching
  - If fertiliser has to be applied in the fallow period, apply it as close to planting as possible.
- Where practical
  - side or top-dress nitrogen during the growing season.
- Consider land levelling to improve surface drainage.

MINIMISING LEACHING & DENITRIFICATION LOSSES IN PERENNIAL CROPS.

- Use split applications, just prior to and during the main growth period
- Place fertiliser where the roots are most active
    - e.g. along the drip or skirt line in tree crops
- Do not apply during the wet season
    - unless this coincides with the major growing season.

VOLATILISATION

Any fertiliser that contains or forms ammonium (NH_4^+) is subject to volatilisation if applied to the soil surface without incorporation.

This applies to:

- All the nitrogen in fertilisers such as Urea, Gran-am (Granulated Ammonium Sulfate) and DAP;
  - And half that in ammonium nitrate fertilisers such as Cal-Am.

That present as nitrate is not subject to volatilisation.

Volatilisation

$$NH_4^+ + OH^- \rightarrow NH_3 + H_2O$$

Occurs under evaporative or drying conditions, with ammonia and water vapour evolving as gases.

Volatilisation Loss will not occur if the fertiliser:

- is placed into the soil, or

- is washed into the soil by rain or irrigation.

Ammonium + Hydroxyl → Ammonia + Water

$$NH_4^+ + OH^- \longrightarrow NH_3 + H_2O$$

↑

Ammonium ions are tightly adsorbed onto clay and organic particles.

Soil pH has an influence!

Ammonium + Hydroxyl → Ammonia + Water

$$NH_4^+ + OH^- \longrightarrow NH_3 + H_2O$$

↑

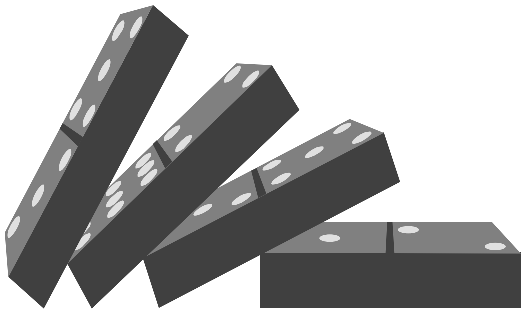
Volatilisation losses from surface applied fertilisers without incorporation are greatest on alkaline (high pH) soils) in which hydroxyl ions predominate.

On strongly-buffered alkaline (high pH) calcareous soils, volatilisation losses from ammonium sulfate can be as great as from urea.

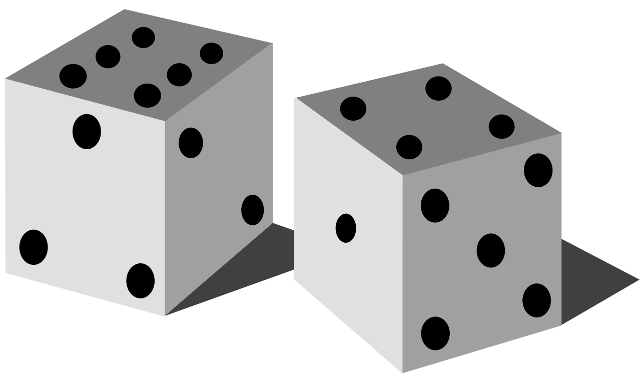
On acid (low pH) soils, volatilisation losses from urea are typically higher than from ammonium sulfate, as urea raises the pH of the soil around the granule as it dissolves.

Heavy dews or light showers of rain predispose to loss

i.e. enough moisture to dissolve the fertiliser, but not enough to carry it into the soil.



There is no safe period of a few days before significant losses occur. They may be appreciable within 24 hours, given the right (wrong) conditions!



VOLATILISATION LOSSES TEND TO BE HIGHER FROM BARE SOIL.

- Allowing the crop to establish itself, or pasture regrowth to occur, may help reduce volatilisation losses:

  - reduced wind speed at soil surface,

  - direct uptake of ammonia by leaves.

SOIL ACIDIFICATION

- Anhydrous ammonia (Big N), urea & ammonium nitrate are equal in their acidifying effect, per kg of N.
- Ammonium sulfate is two (or more) times more acidifying per kg of N.
- Potassium nitrate and calcium nitrate do not acidify the soil.

Nutrient Management

Phosphorus P

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SOIL PHOSPHORUS

- Most present in organic forms.
- Phosphorus is immobile in soils
  - it tends to remain close to where it is placed
- Fixation increases in acid and alkaline soils

PBI or PSI

- Phosphorus Buffer Index

or Phosphorus Sorption Index

= potential of soil to absorb P

  - 70 to 140 = Low = reduce P rate
  - 140 to 280 = Unchanged
  - >280 = High = Increase P rate

PHOSPHORUS IN PLANTS

- Taken up as $H_2PO_4^-$ OR HPO_4^{2-}.
- A key role in energy transfer during photosynthesis and respiration; and in cell division at growing points.
- Stimulates root growth.
- Deficient plants are stunted, dark green in colour (often with purplish leaf veins and stems), and yield poorly.

PHOSPHORUS FERTILISERS

(Phosphate rock contains 13 - 17% P)

PRODUCT	% N	% P	% S	% Ca
DAP	18	20	1.7	
MAP	10	21.9	2.0	
TSP (Triple Super)		20.7	1.4	15
SSP (SuPerfect)		8.8	11	20

DAP

- Most economical source of N & P.
- Commonly used in blends for horticulture
- Ensure N rate is not excessive if used at planting in grain & forage crops.

  DAP is more likely to affect germination and emergence than MAP, TSP and SSP, on account of its higher nitrogen content.

Use of Ammonium Phosphate Fertilisers at Planting

Where both nitrogen and phosphorus are required, and fertiliser is placed with or near crop seeds, the combination of positively charged ammonium ions (NH_4^+) with negatively charged phosphate ions (HPO_4^{2-} & $H_2PO_4^-$) in DAP and MAP can give superior results to superphosphate, by supplying starter nitrogen and stimulating root uptake of phosphorus.

CADMIUM

- P fertilisers contain cadmium (Cd) as an impurity
  - derived from the phosphate rock used in their manufacture
- Fertilisers with a low cadmium content,
  - e.g. < 100 mg Cd/kg p, should be chosen for vegetable production, and in other risk situations.

PHOSPHORUS APPLICATION

- Annual crop
  - best banded with or near the seed or planting material. This ensures early plant access, and reduces fixation.
- Perennial crops and pasture
  – usually applied annually at the start of the main growing season.

Upon application

- Phosphate ions are sorbed onto clay and organic colloids
  - Low concentrations remain in the soil solution
- Little phosphorus is lost through leaching
- P is lost is through soil erosion

Soil pH

Phosphorus fertilisers have little effect on soil pH.

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Sulfur

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SOIL SULFUR

- 70 - 90% is present in organic matter
- Soil disturbance and aeration accelerates the decomposition of organic matter
  - Consequently, sulfur deficiency is more likely to be required in pasture than in cultivated crops.

Sulfur in Plants

- Taken up as sulfate (SO_4^{2-})
- Important in the photosynthetic process, and in the synthesis of protein
- Deficiency symptoms are similar to those of nitrogen, except they first become apparent in the younger leaves

SULFUR - CONTAINING FERTILISERS

PRODUCT	% N	% P	% K	% S
Gran-am (Granulated Ammonium Sulfate)	20.2			24
SuPerfect (Single Superphosphate)		8.8		11
Sulfate of Potash (Potassium Sulfate)			41	18

Gran-am

- Supplies more sulfur than plants need when used as a nitrogen fertiliser.
  - Plants take up about ten times more N than S, whereas Gran-am contains approximately equal amounts of both.
- Commonly used in combination with other nitrogen fertilisers
  - e.g. urea, in fertiliser programs to provide a better balance of N:S.

Sulfate of Potash

- Is too expensive to use as a source of sulfur;
- Only use Sulfate of Potash
  - in soils and crops in which the chloride present in Muriate of Potash will be detrimental. The sulfur will be a bonus.

Gypsum

- Where used as a soil amendment, e.g. >2.5 t/ha, additional sulfur will not be required

Nutrient Management

Soil Interpretation

Micronutrients

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The Micronutrients

B	**boron**
Cl	**chlorine**
Cu	**copper**
Fe	**iron**
Mn	**manganese**
Mo	**molybdenum**
Zn	**zinc**

Micronutrients

- Required in small amounts by plants
    - Often referred to as "Trace Elements".
- The concentrations in soils bears no relationship to that in plants.
- Iron (Fe) and manganese (Mn) are among the most abundant elements in soils.

Availability

- Lower in sandy soils and soils with low organic matter
- Only a small part of the total is readily available for plant uptake
- pH is a major determinant of availability

Micronutrient Soil Tests

- Less reliable than Plant Tissue Tests.
  – Tests for zinc and copper are the most reliable.
- Plant available concentrations of iron and manganese can fluctuate widely
  – as the oxidation state of the elements change in the soil with wetting and drying (aeration). Deficiency/toxicity may be temporary, and associated with water-logging.
- Soil tests for molybdenum are not performed.

Mobility in Soil

CATIONS (+)

Cu, Fe, Mn & Zn are immobile.

ANIONS (-)

Molybdate ranks second behind phosphate of the nutrient anions in terms of its lack of mobility

NON-IONIC

Boron as H_3BO_3 is extremely mobile, similar to nitrate.

Soil Applications of Copper (Cu) and Zinc (Zn)

- Pre-plant applications should be applied into the soil.
  - Incorporate after application if broadcast or sprayed.
- Annual applications banded with the seed at planting
  - e.g. Granulock Supreme Z can be very effective in annual crops (reduced fixation, early access for young roots).
- In sugarcane apply in the planting fertiliser
- In trees, it may be best to concentrate fertiliser in a 30 cm band under the drip line rather than as a overall broadcast treatment.

Copper will not be required as a fertiliser where used as a fungicidal spray.

Soil Applications of Iron and Manganese

- Not recommended in most situations.
- Foliar sprays are usually more effective.

Soil Application of Boron

- Think of boron as the nitrogen of the trace elements.
  - Subject to leaching.
- Toxicity is easily induced
- As there are limits to the amount of boron which can be safely applied at planting, crop requirements can not usually be met by band applications with or near the seed, (apply pre-plant or to the foliage instead).
- In tree crops, spread evenly under the canopy, but not too close to the trunk.
- Where required, boron usually needs to be applied at least annually, if not more frequently.

MOLYBDENUM

- Required in the smallest amount of the recognised trace elements.

- *Rhizobium* bacteria in legume nodules require about ten times more molybdenum than the host plant.

CHLORIDE

Rarely in short supply, particularly in Australia.

Most Common Deficiencies

- **Boron** - on soils low in organic matter and in high rainfall areas; in fruit, nut and vegetable crops, e.g. cruciferous and root crops, and occasionally in maize and lucerne.
- **Copper** - most likely to occur on sandy soils, e.g. wheat, sugarcane, pasture.
- **Molybdenum** - on acid soils; in legumes and some vegetables, e.g. cucurbits, lettuce, cauliflower.
- **Zinc** - on alkaline (high pH) soils and in sandy soils; in most crops and pasture.

Most Common Toxicities

BORON

- Toxicity is easily induced by excess/uneven fertiliser application, concentrating the fertiliser on too small an area, or applying too much boron at planting

MANGANESE

- May occur on acid soils

MOLYBDENUM

- Rarely toxic to plants

Diagnosis of Disorders

SOIL ANALYSIS

Reliability varies with the nutrient and other factors.

PLANT TISSUE ANALYSIS

Regarded as a better diagnostic tool than soil analysis where interpretative data is available.

OTHER

Deficiency symptoms

Local experience

Test strips

Foliar Sprays

- May be used in place of or in conjunction with soil applications.

- Plant demand can usually be met through foliar sprays without burning the foliage.

- Foliar sprays provide a means of applying micronutrients evenly at low rates.

Micronutrient Mobility in Plants

- Molybdenum (Mo) is mobile

- Other trace elements

(B, Cu, Fe, Mn, Zn) are immobile or only slightly mobile.

Timing of Sprays

- Prevention is better than cure
- If a deficiency is allowed to express itself, yield loss will have already occurred
- In annual crops, foliar micronutrient sprays are normally applied early in the growing season
- In tree crops, they are normally applied to new growth, i.e. the spring flush.

Chelates

- Organic ring compounds that form a claw-like ring around metallic ions
- Copper, iron, manganese & zinc (all positively charged cations) are available as chelates.
- Boron and molybdenum are not available in the chelated form.

Chelates

- **Advantages**
  - Not fixed as quickly in the soil as sulfates. Seek advice from supplier on which products to use at different soil pH.
  - Wider compatibility with other fertilisers in solution, e.g. foliar sprays.

- **Disadvantage**
  - Cost.

Nutrient Management

Plant Tissue Interpretation

growcom
together we grow

USES

TREE CROPS

- **Used to monitor plant nutrient status, eg. N.**
- **Generally used in conjunction with soil tests.**

ANNUAL CROPS

- **Used to predict side or top-dress fertilizer requirements.**

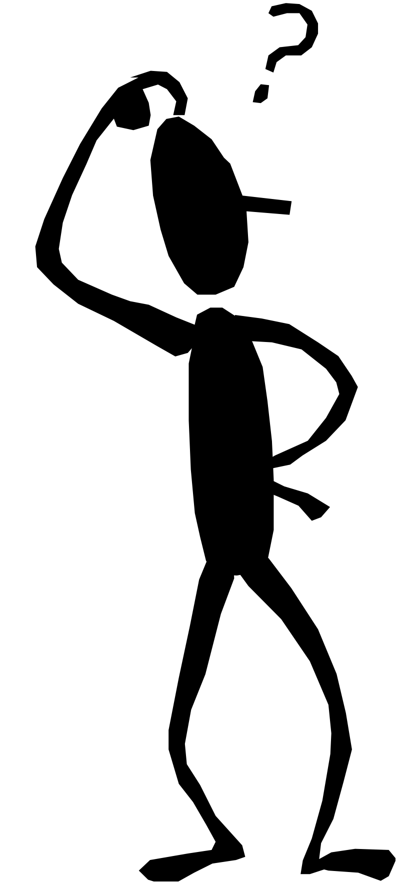
PROBLEM SOLVING

MICRONUTRIENTS (TRACE ELEMENTS).

Plant tissue analysis allows you to sort results into the following categories:

- **Deficient - symptoms present, large yield reductions.**
- **Low - hidden hunger, possible yield loss.**
- **Optimum or Normal**
- **High - luxury uptake?**
- **Excessive or Toxic - visual symptoms, yield loss.**

The laboratory results do not tell you first hand how much nutrient (N, P, K, etc.) to apply!



To advise on fertilizer rates, the following information is required:

- Existing fertilizer program;
- In tree crops, the age of the trees.

Be aware that there are many reasons (other than nutritional) why Plant Tissue may test high or low in a nutrient!

- Incorrect sampling (plant part or growth stage);
- Sampling too soon after applying fertilizer to soil or leaves;
- Use of micronutrient based fungicides, eg. copper;
- Soil or dust contamination (high iron and aluminium);
- Pathogens affecting root or leaf growth - nematodes, insects, disease, *e.g. phytophthora root rot in avocado;*
- Physical barriers, *e.g. soil compaction;*
- Stress - drought, water-logging, heat, cold, frost, e.g. moisture stress can impede translocation of immobile elements such as calcium and boron within plants.

Before Interpreting Results

The first thing to check is that the plant tissue was sampled correctly!

Some nutrients, e.g. N, P & K, are mobile in plants.

Others, e.g. Ca & B, are immobile!

If N, P and K are high and Ca and B are low:

Check whether plant tissue is younger than recommended.

If N, P and K are low and Ca and B are high:

Check whether plant tissue is older than recommended.

When Problem Solving

- Look for the cause of the poor growth.
- Don’t attempt to develop a fertiliser program for other nutrients until after the growth limiting factor(s) have been corrected.

Identify the problem (deficiency and/or toxicity); Take action to correct it; & Use a basic district program for the other nutrients.

- Other nutrients may well test high initially, but on correction of the growth limiting factor(s), these concentrations are likely to return to the optimum or normal range due to dilution in the extra growth.

- When growth returns to normal conduct another test & then develop a fertiliser program for the other nutrients.

COMBINED SOIL, PLANT TISSUE & WATER ANALYSES

At the same time, can assess :-

- Soil's ability to supply nutrients;
- Plant's ability to take them up;
- Water quality, effect on soil and plants, nutrient content, etc.

Soil and Plant Tissue Samples should be taken at the same time:

- Convenience;
- Avoids seasonal variation.

Order of Interpretation

1. Plant;

2. Soil;

3. Evaluate status in both, to see if agronomically they make sense.

Low/Low 

High/High 

Low/High ?

High/Low ?

Look for:

- Interactions.
- Other factors that may affect nutrient uptake and utilisation.
- Other sources from which the nutrient might have come, e.g. fertiliser, irrigation water.