Hazelnuts 101

Nutrients and Nutrient Management

What do plants need?

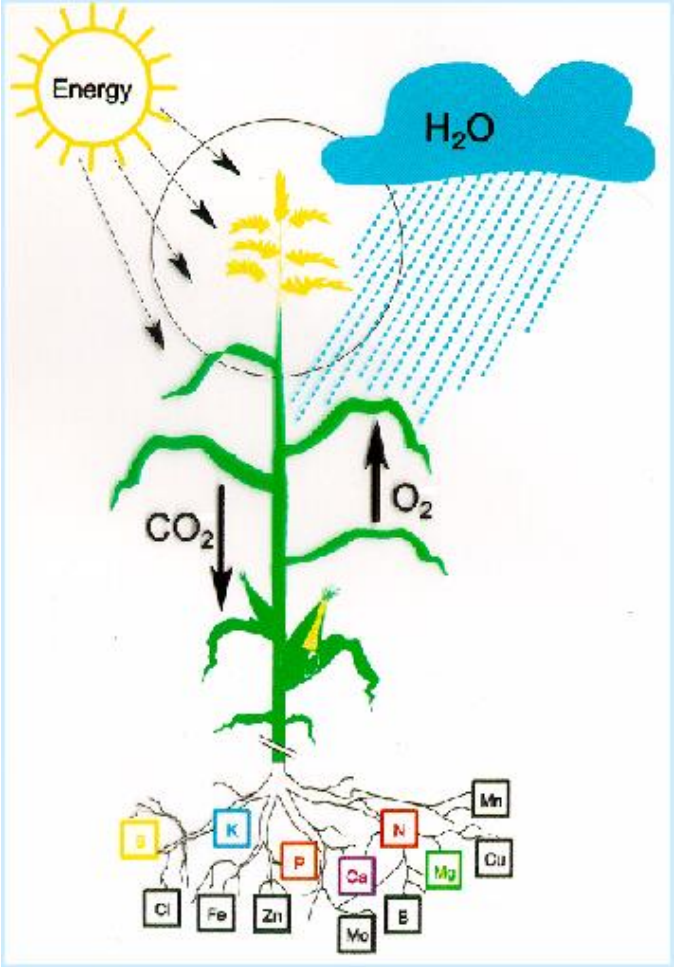
- *Plants require energy from the sun to supply light for photosynthesis and adequate temperatures for metabolic processes*
- *Carbon dioxide for organic matter formation and oxygen for respiration are also required*
- *Other requirements include water and nutrients*

1. Energy:
- Light for photosynthesis (production of sugars, etc.)
- Temperature for metabolic processes

2. Gases:
- Carbon dioxide (CO_2) as basic component of carbohydrates, lipids and proteins
- Oxygen (O_2) as basic component and for catalytic respiration

3. Water: as basic component

4. Nutrients – micro and macro nutrients



What nutrients do plants need?

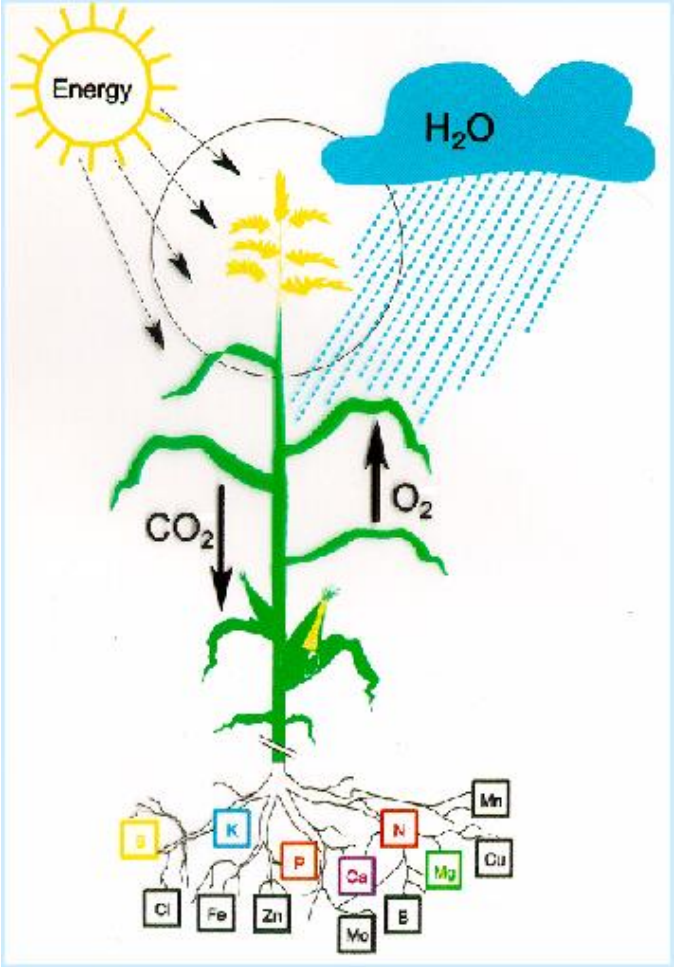
- *In soil, nutrients interact with one other leading in changes to availability to plants*
- *If there is an imbalance or too much or too little of a particular nutrient, it can reduce the ability of a plant to access other nutrients*
- *pH can also alter the availability of nutrients*

1. Macronutrients (require larger quantities):

- Nitrogen
- Phosphorus
- Potassium
- Calcium
- Magnesium
- Sulphur

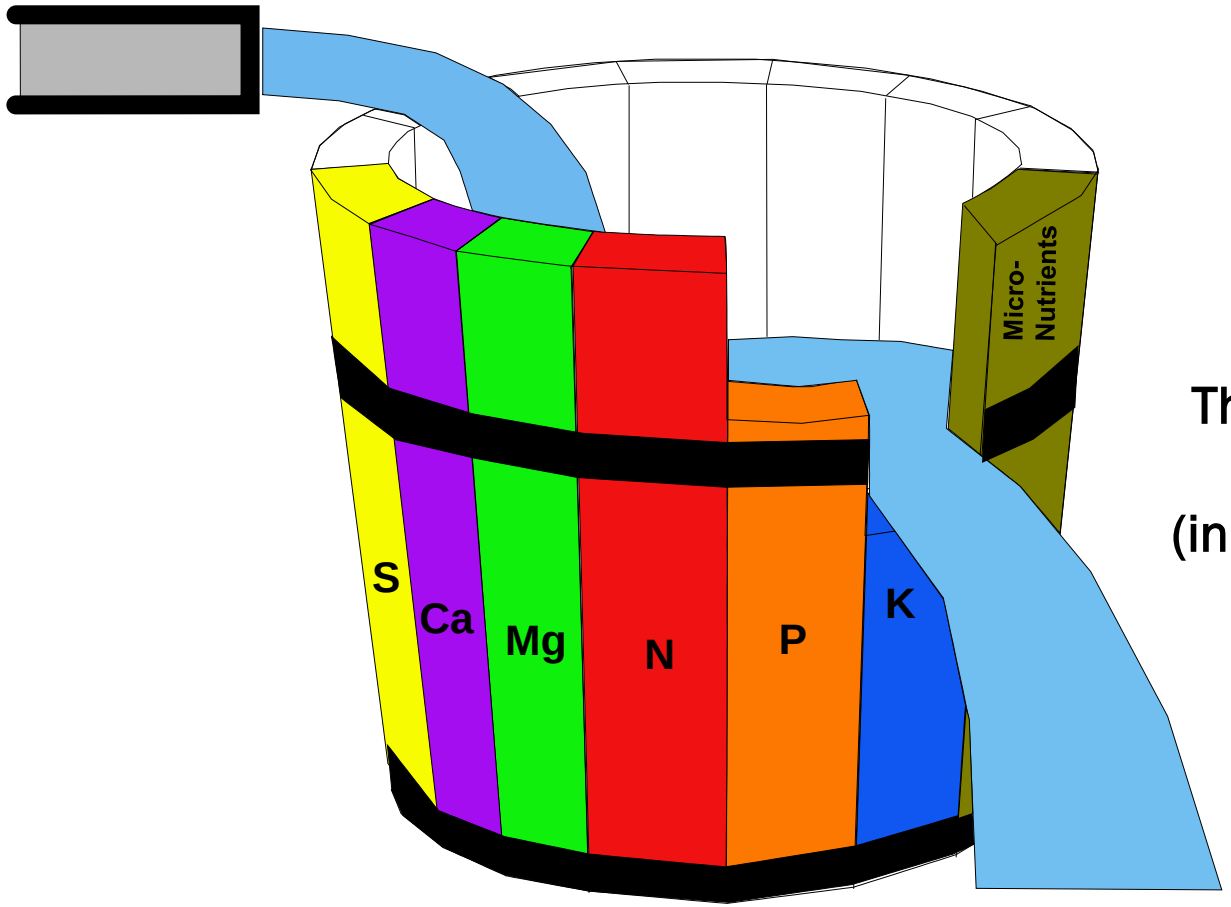
2. Micronutrients (require smaller quantities):

- Iron
- Zinc
- Manganese
- Copper
- Boron
- Molybdenum
- Chloride



The Law of the Minimum (from Liebig 1843)

- ***Liebig's law of the minimum states that the nutrient which is in the shortest supply (in this example K) limits plant growth, despite all other nutrients being in adequate supply***



The element which is in shortest supply (in this case K), limits the yield

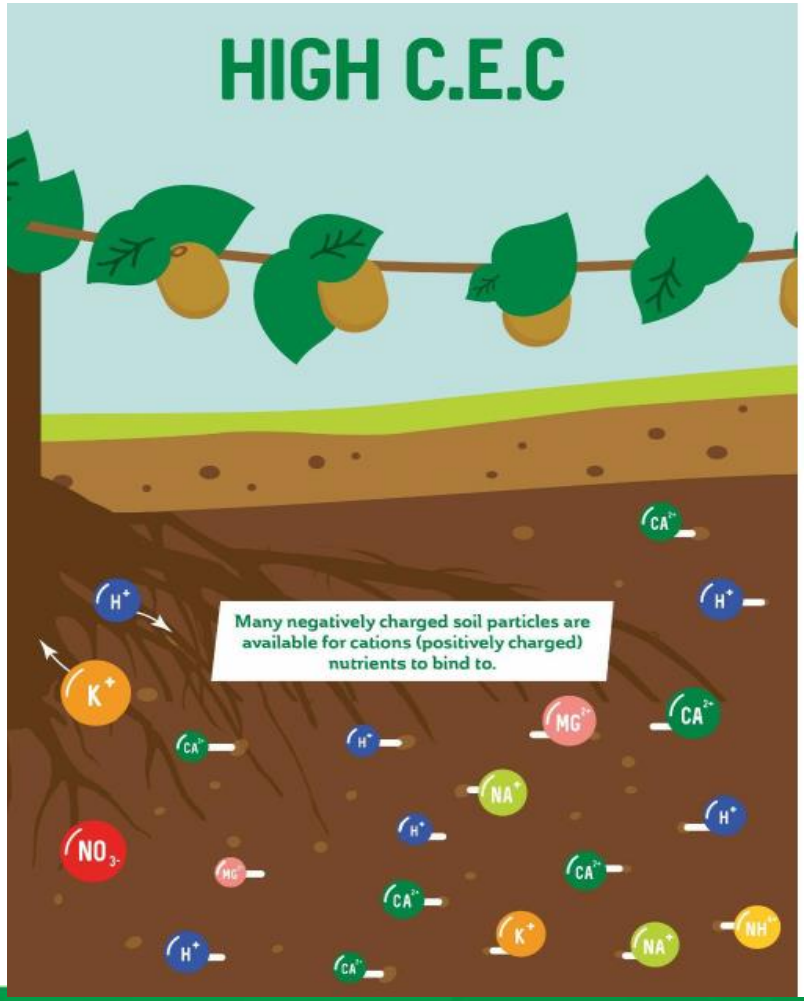
Soil tests - Cation exchange capacity (CEC)

Soil Chemistry

- ***Soils with low organic matter often have low CEC***
- ***Soils with lots of sticky clay often have higher CEC***
- ***Sand and silt typically have lover CEC***

- Plant nutrients exist as molecules floating around in the water content of the soil
  - Some are positively charged (cations)
  - Some are negatively charged (anions)
  - Soil particles are negatively charged
  - Opposites attract so positively charged molecules will bind to soil particles;
    - Calcium, mag, potassium, sodium (NA+) etc are + charged

The amount of negative sites in a soil and so ability of the soil to hold cations is measured as the CEC



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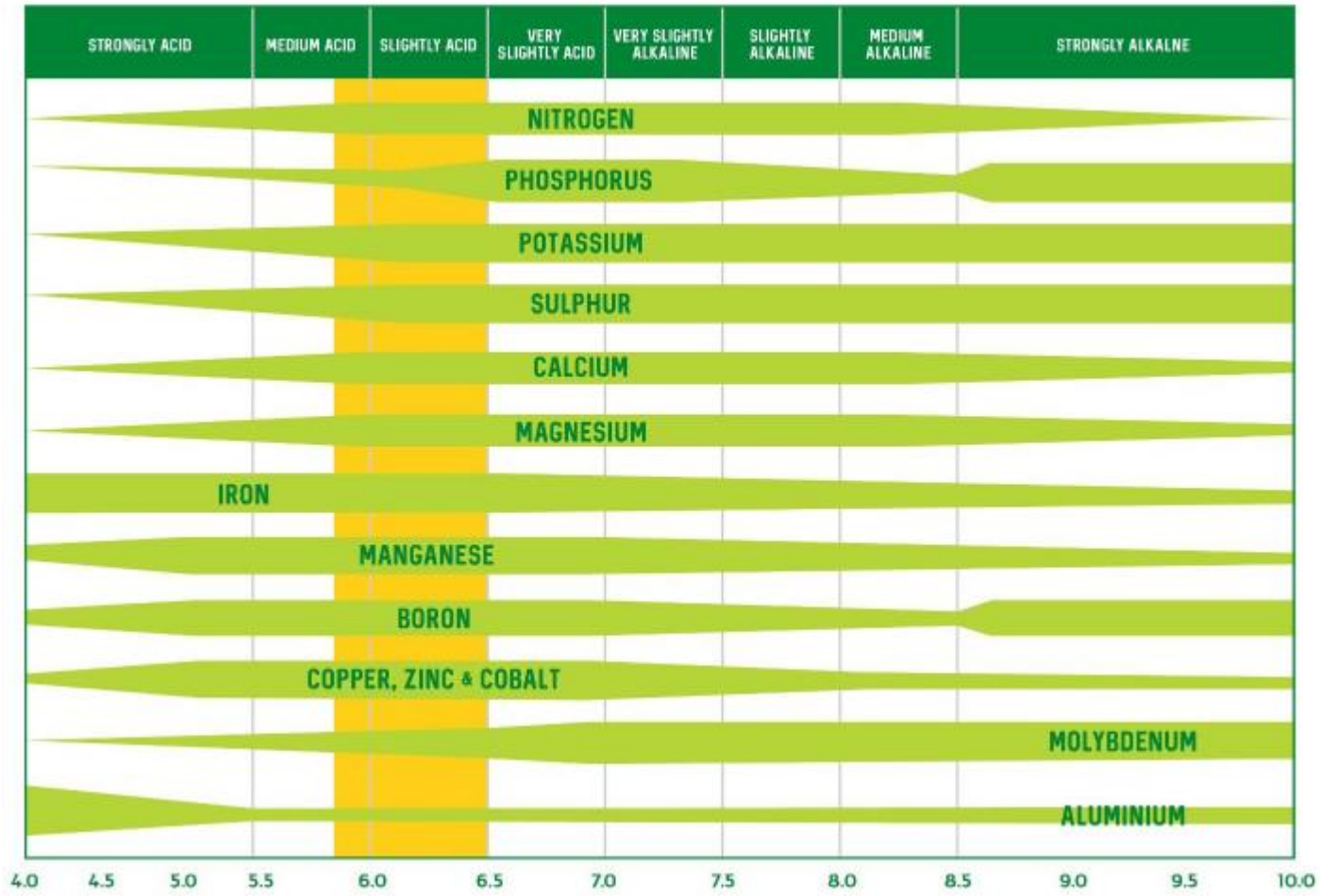
The effect of pH (acidity)

- ***Some nutrients become more or less available with changes in pH***



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Principals of nutrient supply from fertilisers and composts

- ***The best outcomes might require multiple small applications rather than a single large application***

The 4 Rs of nutrient applications

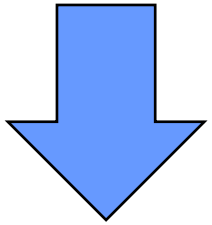
- Right product
- Right rate
- Right place
- Right time

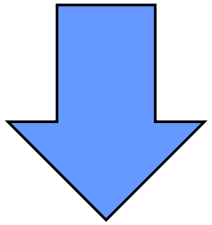
But how do we know what is the right product and right rate……!!!!

How do we know what nutrients we have and/or need?

- ***Nutrient budgets help calculate crop removal plus losses plus amounts used for root and shoot development to give maintenance dressing requirements.***
- ***Maintenance dressings will keep nutrient levels static.***
- ***Capital dressings increase nutrient levels***

- Soil testing (15cm).....leaf testing, petiole and fruit testing





1st - testing for critical shortages that effect yield or productivity

2nd - testing for nutrient removal (or losses) to maximise production or quality

Soil tests are a <u>chemical measure</u> of a <u>biological system</u>
- .....so are "variable"

"Looking at trends over time are important"

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Soil Sampling - the first crucial step

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- Testing should be carried out for each block before deciding on any nutrient /fertiliser regime
- For some crops, soil tests can be complemented by plant/tissue analysis at specific growth stages.

Soil Sampling - protocol for cropping paddocks

- ***Soil sampling protocol aim to assess the average fertility of a paddock.***
- ***Protocols should aim to collect as representative a sample as possible.***
- ***Any unusual areas should be avoided.***
- ***Repeated sampling will provide valuable information on trends over time.***

- Take one sample (at least 15 cores) per block
- Use 15cm (6 inch) corer
- Set up transects using GPS, or permanent markers (such as tree lines).
- Collect cores from a transect, running any across cultivation lines.
- Avoid atypical areas e.g. fencelines, shelterbelts, gateways, troughs, irrigation runs, compacted areas.
- Repeat sampling at similar time of year (winter ideal) .
- DO NOT sample within 3 months of fertiliser application.

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Variability in soil tests

- *Soil tests are a chemical measure of a biological system*
- *Soil tests are inherently variable because of laboratory, spatial and temporal errors*
- *The different soil tests have a different degree of variability as shown*
- *In general as soil test levels increase so to does the variability*

Soil test	Variability %	For example
pH	2 – 5	pH 6.0 ± 0.3
K	20 – 30	K 6 ± 3
Olsen P	15 – 20	Olsen P 25 ± 10
S	20 – 40	S 10 ± 6

Soil N Tests

- ***There is no perfect Soil Nitrogen test, due to the soil N cycle moving relatively quickly.***
- ***Mineral N test can be difficult to do due to the sampling depth required***

Potentially Mineralisable Nitrogen (PMN) 'NEW'

- estimates amount of N available due to soil mineralisation.
- sampled to 15cm or 30cm depth.
- A 'new' calculator gives an estimate of how much N will become available each month over the next four months

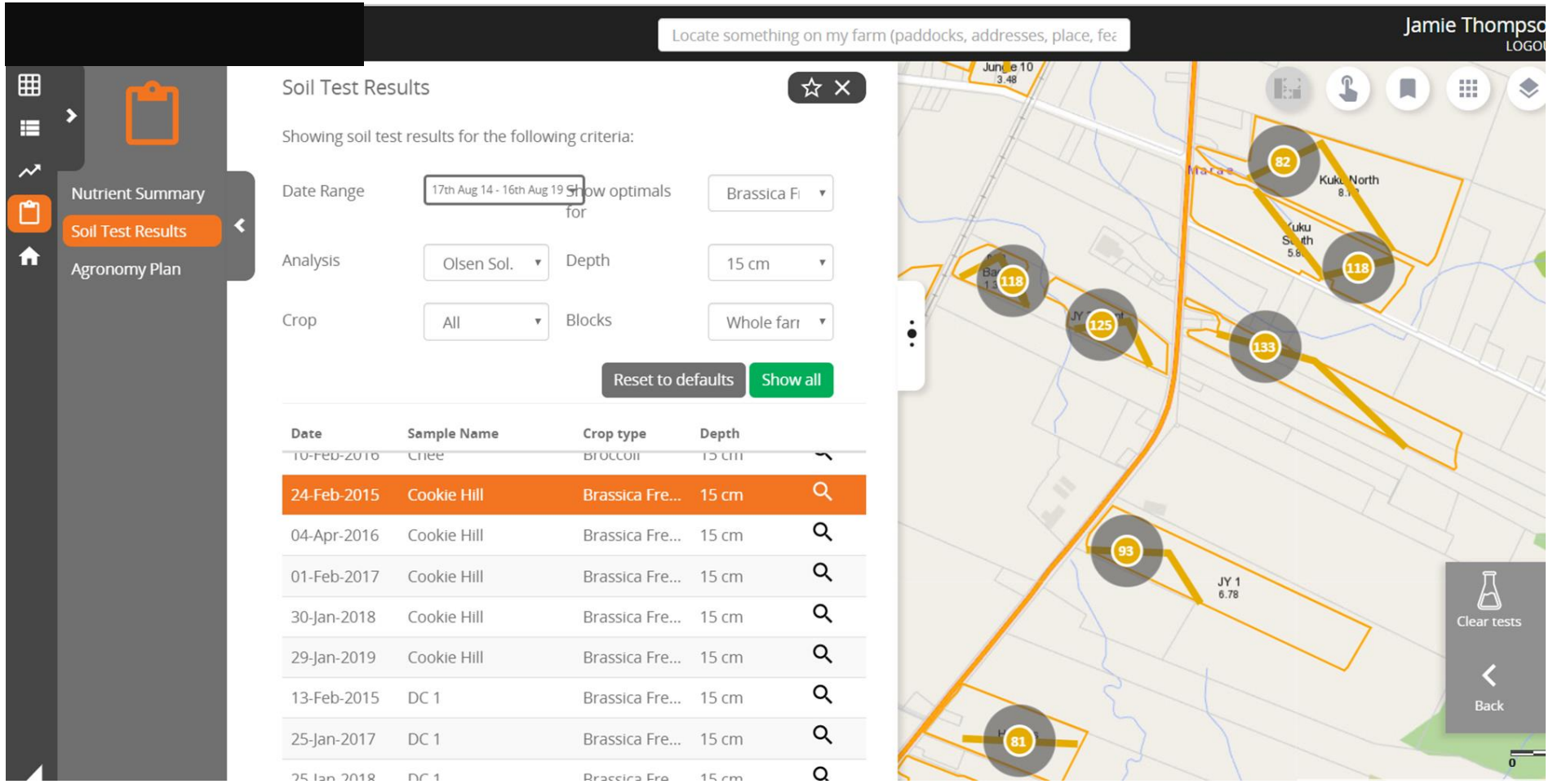
Mineral Nitrogen test (ammonium and nitrate)

- provides a snap-shot of the immediately available mineral N
- usually sampled to 60-90cm depth
- Has being used by growers in early spring to determine how much N fertiliser should be applied.

These soil N tests are available through ARL

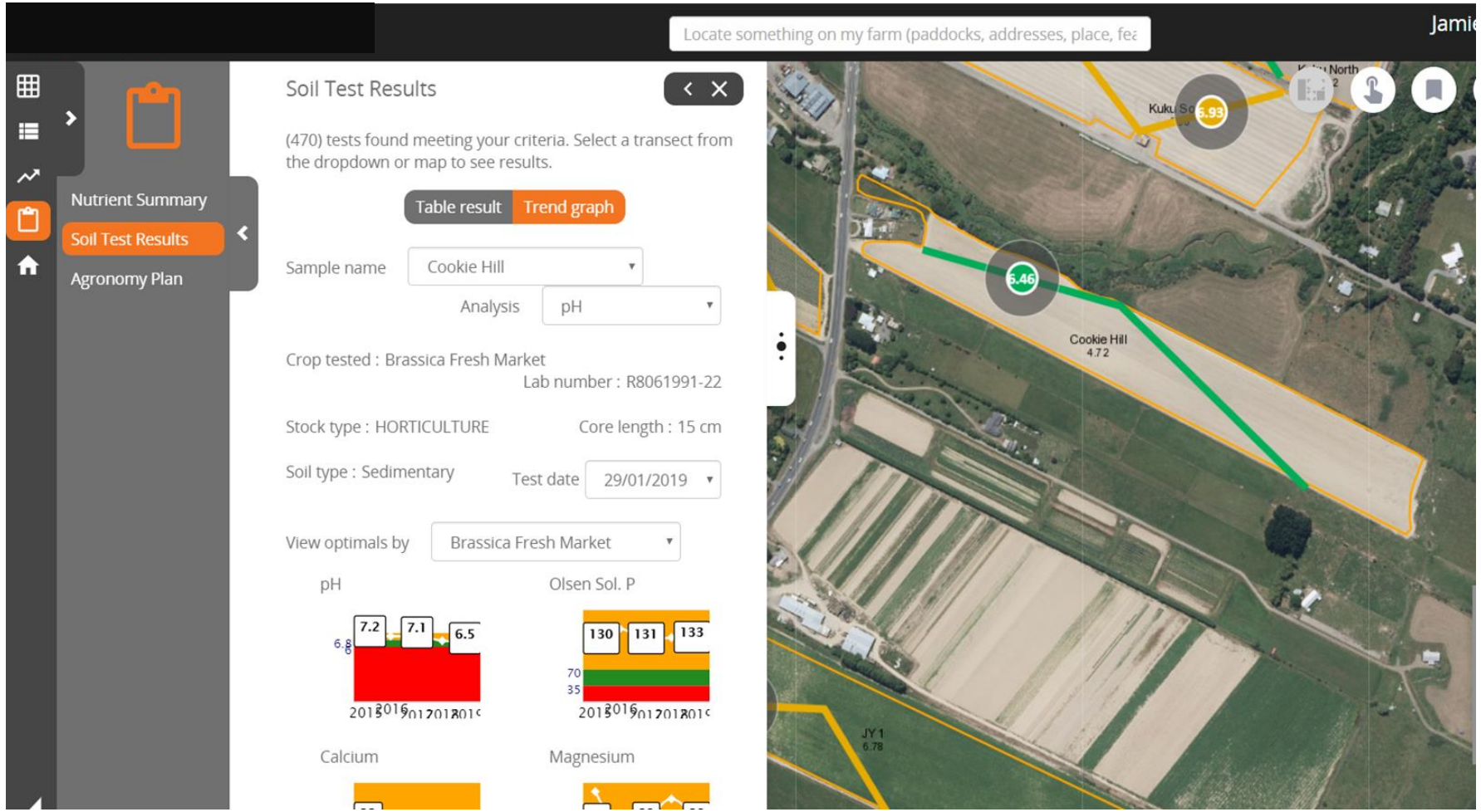
‘Hawkeye’ a free mapping tool to help nutrient management

- ***HawkEye will show where tests are taken from for consistent year on year soil testing by GPS***
- ***Soil test results show on a spatial platform***



Trends over time important

- ***HawkEye will graph soil trends over time using HawkEye mapping programme***



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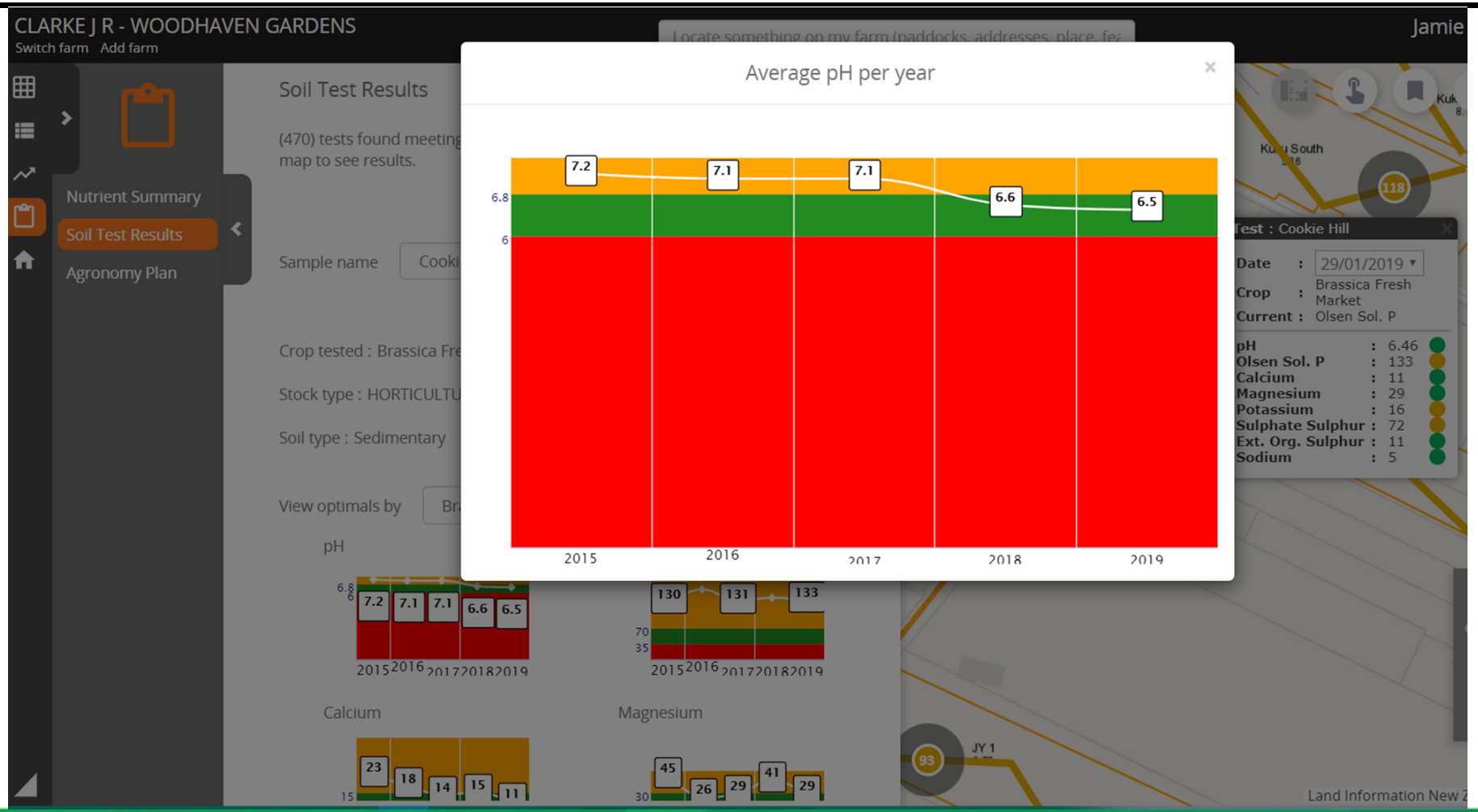
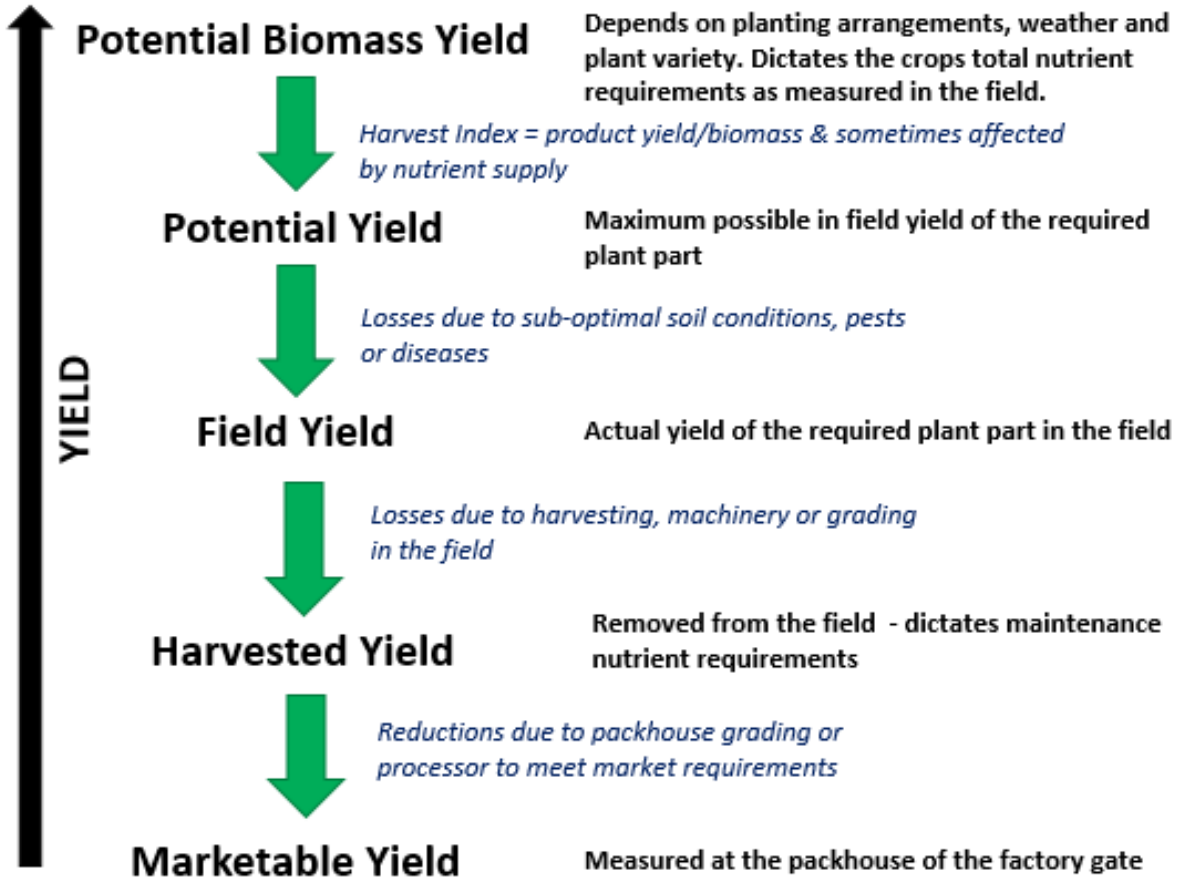
HawkEye Mapping - example of trends of pH over time

- ***Trends are important to show direction of soil nutrient status***



Differing Yields and their relationships

- ***Nutrient uptake and yield are mutually dependent.***
- ***Potential yield sets the top limit for the crop nutrient uptake requirements***
- ***Field yield may be less than potential due to stress such as water availability, pests or diseases***



We need to know what we are trying to achieve - yield for mature trees or growth for young trees as the approaches will differ……

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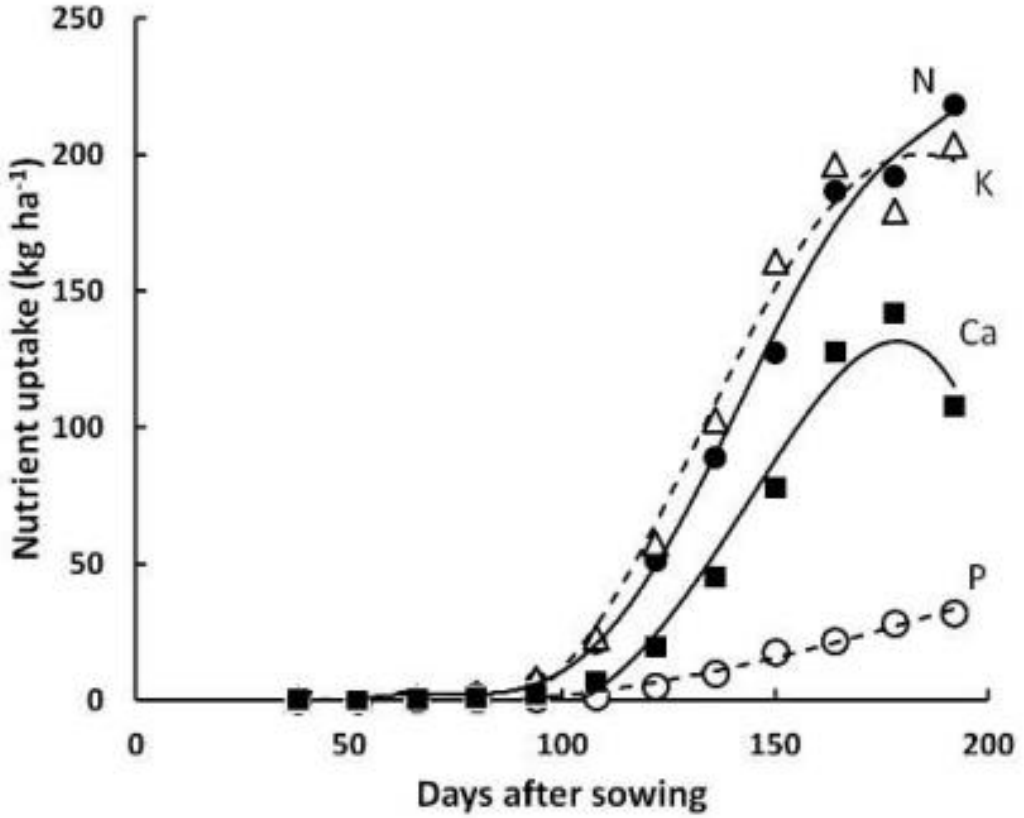
Matching nutrient supply with nutrient uptake

- *Important to match uptake and supply as closely as possible*
- *If high % of nutrients are applied upfront (at planting) then risk of loss higher.*

Onion crop Nutrient uptake



Tissue testing - horticultural crops

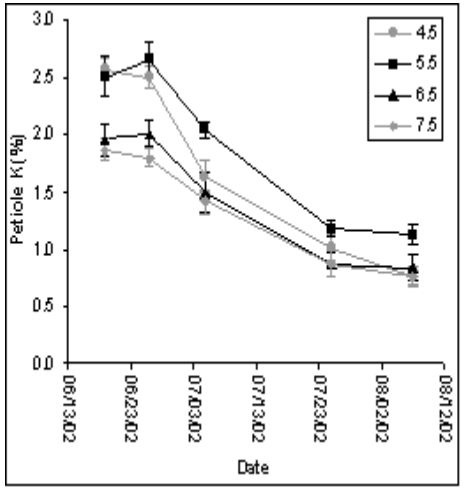
- ***When tissue testing horticultural crops, it is important to follow the recommended procedure for each particular crop.***
- ***This includes sampling at the correct growth stage or time or season, and sampling the correct plant part.***
- ***General rule of thumb: sample the youngest fully expanded leaves***

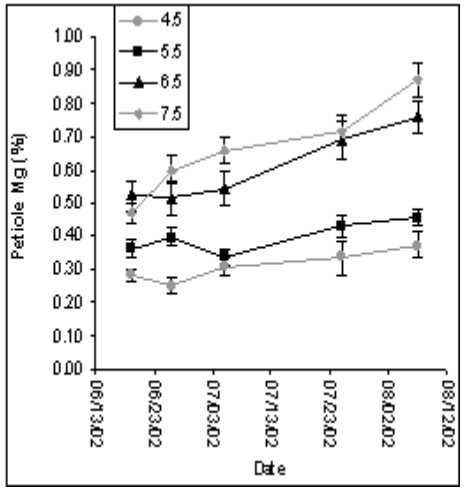
Two main reasons for testing crops:

1. To monitor crop growth, particularly high value orchard crops.
   - Specific trees/branches can/should be marked for sampling.

2. As a diagnostic tool to investigate a particular problem with crop growth
   - collect paired samples for comparison: healthy vs. affected.

3. ARL sampling guide (when & which plant part)





Forms of nutrient supply

Nutrient Supply Products

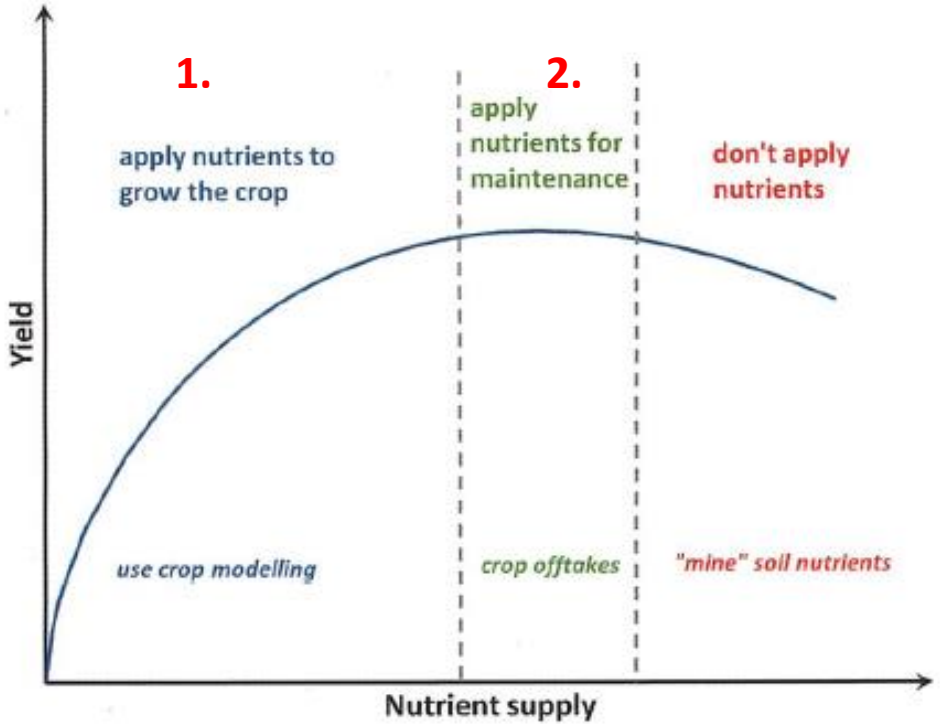
- Solid fertilisers
- Granular fertilisers
- Compound fertilisers
- Blended fertilisers
- Controlled release fertilisers
- Liquid fertilisers
- Suspension fertilisers
- Foliar fertilisers
- Composts & other organic waste materials
- Micobial-based fertilisers or soil amendments

Basic Nutrient recommendations

Principals of fertiliser recommendations

- ***Two major components of a fertilizer nutrient recommendation:***

1. ***How much nutrient is required to grow the crop***
2. ***How much nutrient is needed for maintenance (i.e. will be needed to replace those nutrients removed by the crop)***



1. **Nutrients required to grow the crop;**

   Amount of extra nutrient required = amount of nutrient required for target yield less the soil supply of the nutrient.

2. **Maintenance applications**

   The amount of nutrient removed in the harvestable portion of the crop represents the loss of nutrient from the soil.

Upper limit of yield is set by crop characteristics and weather - not by adding more nutrients

Capital Applications of P, K & Mg.

Principals of fertiliser recommendations

- ***Because soil samples are taken from 15cm depth in hort situations, capital fertiliser inputs need to be doubled compared to pastoral paddocks to generate the same lift in soil fertility.***
- ***It is normally uneconomic to lift the K status of sedimentary soils and ash soils – full or partial replacement of K removed is often more appropriate.***

Amount of capital fertiliser (kg/ha) required to increase soil test results by 1 unit for various soils where fertiliser is incorporated to 15cm depth.

Phosphate

Soil type	Average (range)
Sedimentary	10 (8-12)
Pumice & Peat	13 (10-16)
Volcanic Ash	22 (14-36)

Potassium

Soil type	Average (range)
Most Sedimentary	250 (200-500)
Pumice	90 (70-120)
Volcanic Ash	120 (90-160)

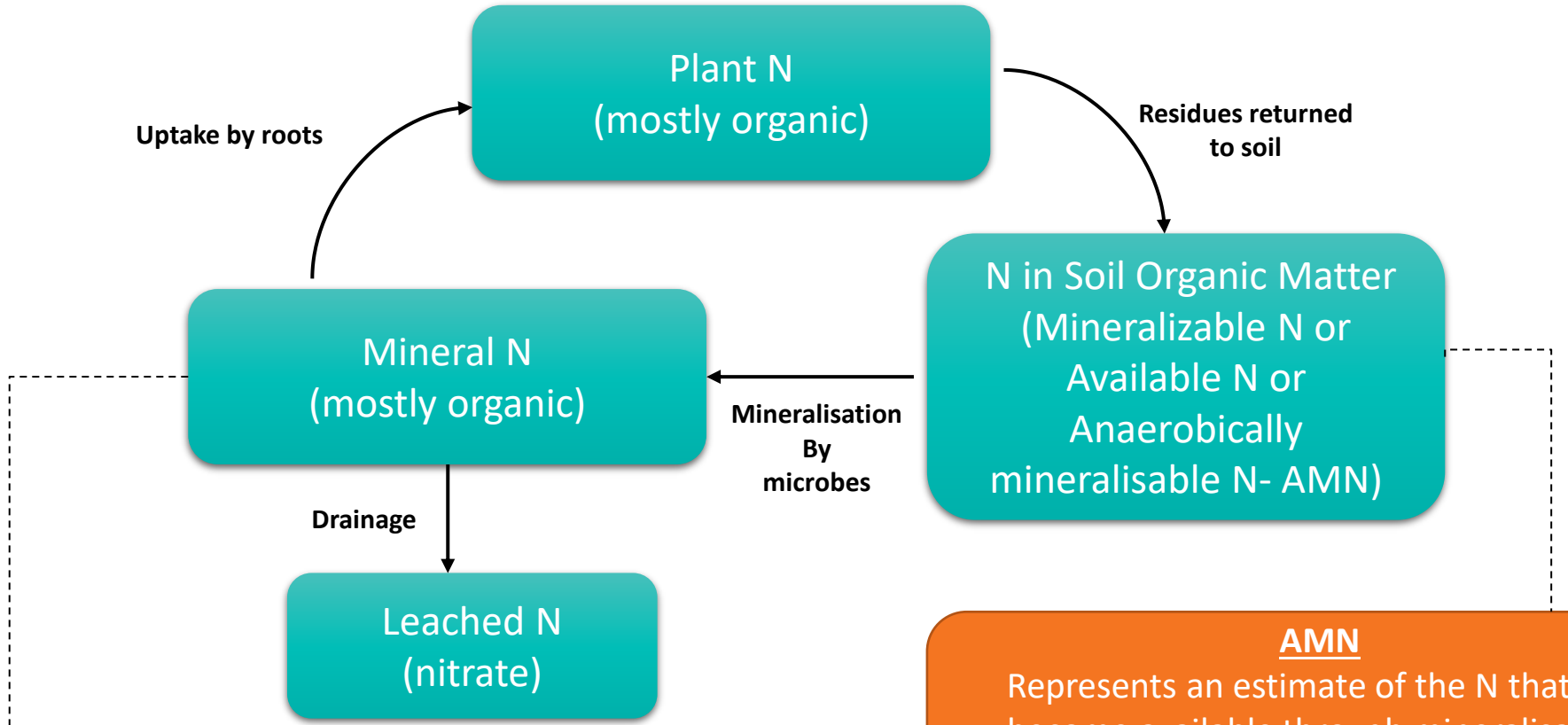
Magnesium

Soil type	Estimated Average (range)
All mineral soils	15 (8-20)

Nitrogen: the most important nutrient for crops

Soil Nitrogen

- ***Nitrate leaching occurs when drainage follows rainfall or irrigation***
- ***Volatilisation can occur when N applications are followed by windy conditions, high soil temperatures, lack of crop cover or high rates of N are applied.***



Mineral N
Represents the N immediately available to the plant and doesn't account for what may become available during the life of the crop from the soil organic matter

AMN
Represents an estimate of the N that will become available through mineralisation through-out the season and is reported as kg N/ha.

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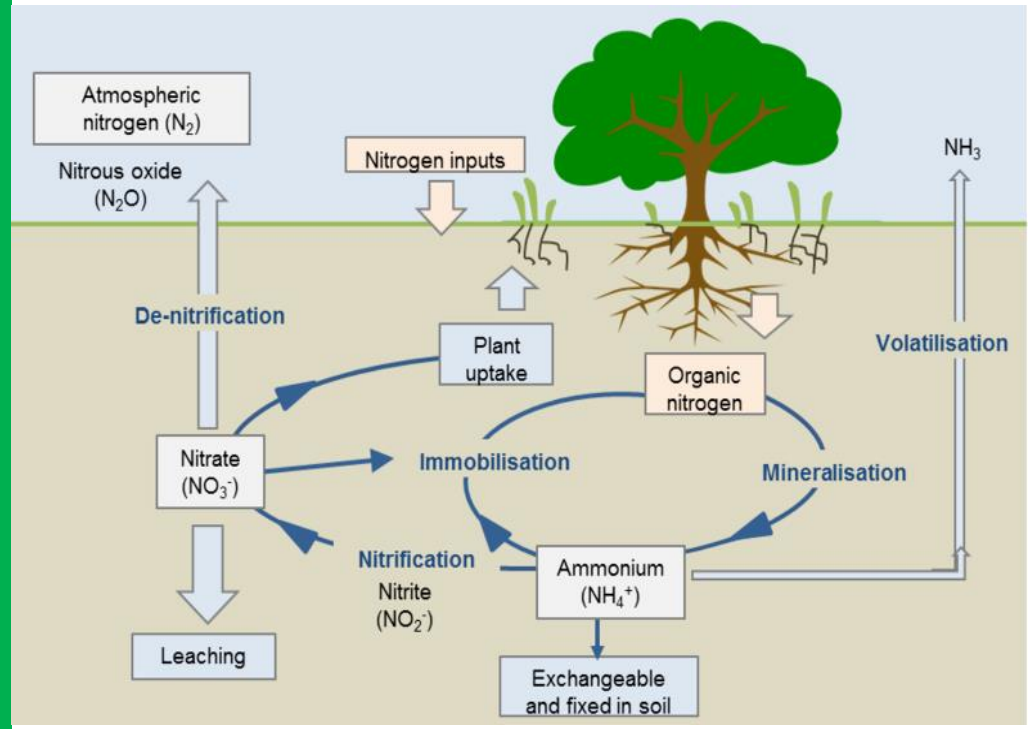
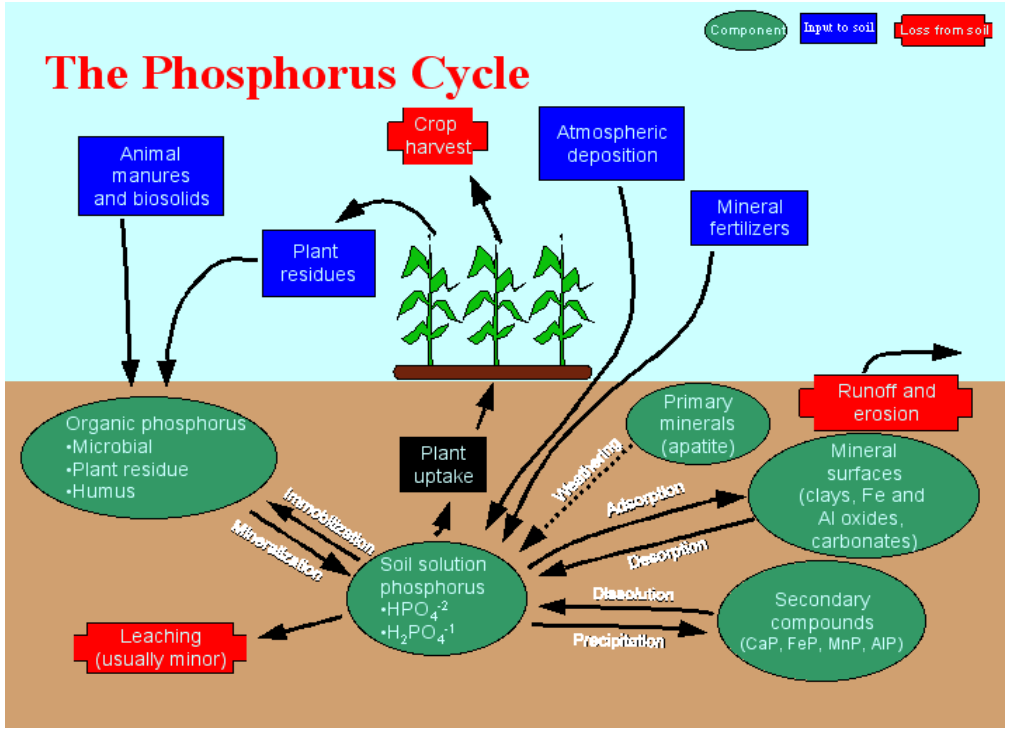
Nutrients for Hazel Nuts

- Base fertility should be built up before planting
- Tolerant of lime rich soils with pH 6 to 7
- Surface apply fertiliser - not in planting hole
- Early applications on new plantings should be to encourage growth - i.e. a Nitrogen rich balanced NPK mix such as Nitrophoska Select
- When nut production starts - apply balanced fert in spring. Take care on lighter soils - split applications may be better suited to reduce losses
- Do leaf analysis on mid-shoot leaves in January

Nutrient loss pathways (N & P)



Nitrogen = Drainage or Volatilisation



Phosphate = Runoff or erosion

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Role of OverseerFM – what it models

Nutrient Budgeting

- ***Useful to view trends over time (years) of nutrient balances and losses.***
- ***Cannot be used to represent within-season variations***
- ***Greenhouse gas emissions (t/ha e-CO2)***

➢ Overseer models the cycling and flow of nutrients to estimate;

- ✓ Losses of key nutrients including N & P
- ✓ Losses of Agricultural greenhouse gases
- ✓ Balance of inputs and outputs of essential plant nutrients to indicate sustainability of nutrient supply to plants
- ✓ Effect of different crop rotations, nutrient inputs, residue management and fallow periods on availability or losses of nutrients

(kg/ha/yr)	N	P	K	S	Ca	Mg	Na
Nutrients added							
Fertiliser, lime & other	2	0	0	0	3	0	0
Rain/clover N fixation	30	0	3	6	4	9	51
Irrigation	15	1	9	15	55	13	56
Nutrients removed							
As products	1	0	2	0	0	0	0
Exported effluent	0	0	0	0	0	0	0
As supplements and crop residues	0	0	0	0	0	0	0
To atmosphere	9	0	0	0	0	0	0
To water	17	0.2	7	28	53	11	44
Change in farm pools							
Plant Material	0	0	0	0	0	0	0
Organic pool	19	18	0	-8	0	0	0
Inorganic mineral	0	-1	-18	0	-5	-9	-10
Inorganic soil pool	0	-17	21	0	13	18	72

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Practical things to help reduce nutrient losses

Spreading

- Spread evenly, avoiding build-ups
- Use calibrated spreaders

Mulching

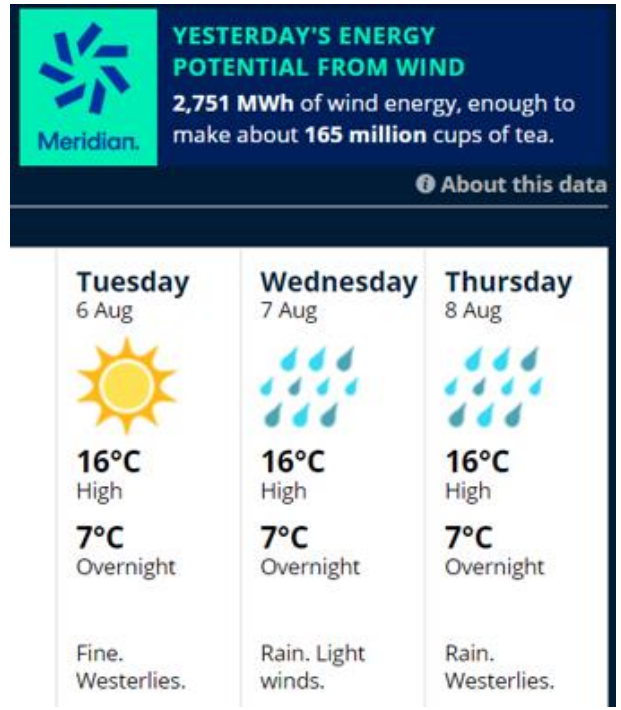
- Mulch only …..don’t rotary hoe !

Practical things to help reduce nutrient losses

Storage of nutrients

- Avoid moist areas & wet periods
- Store away from waterways, drains

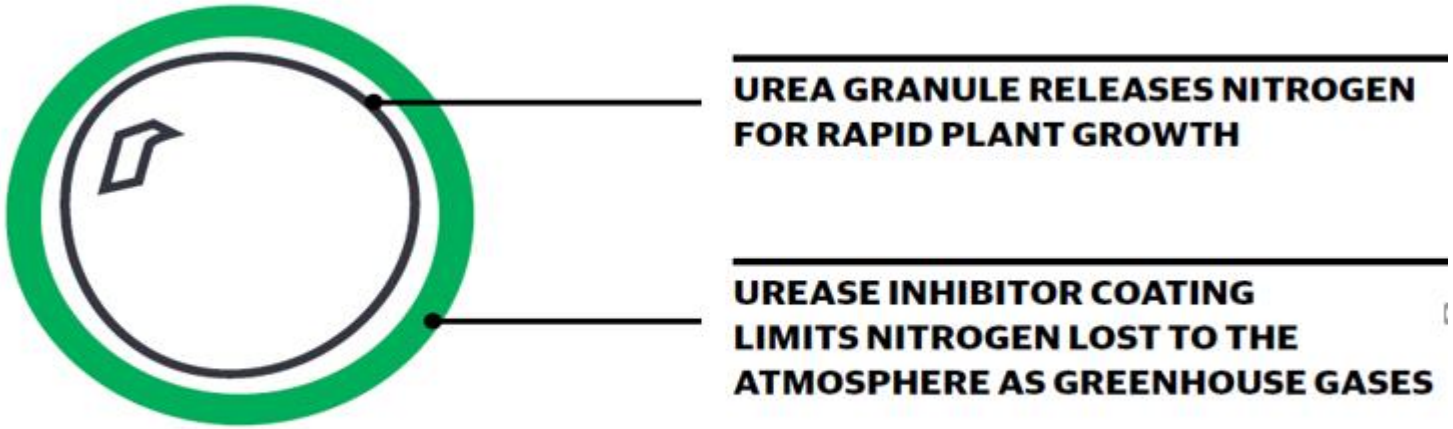
Watch the Weather



- Avoid periods of wet and when rain forecasted to spread nutrients

Practical things to help reduce nutrient losses

Product Selection

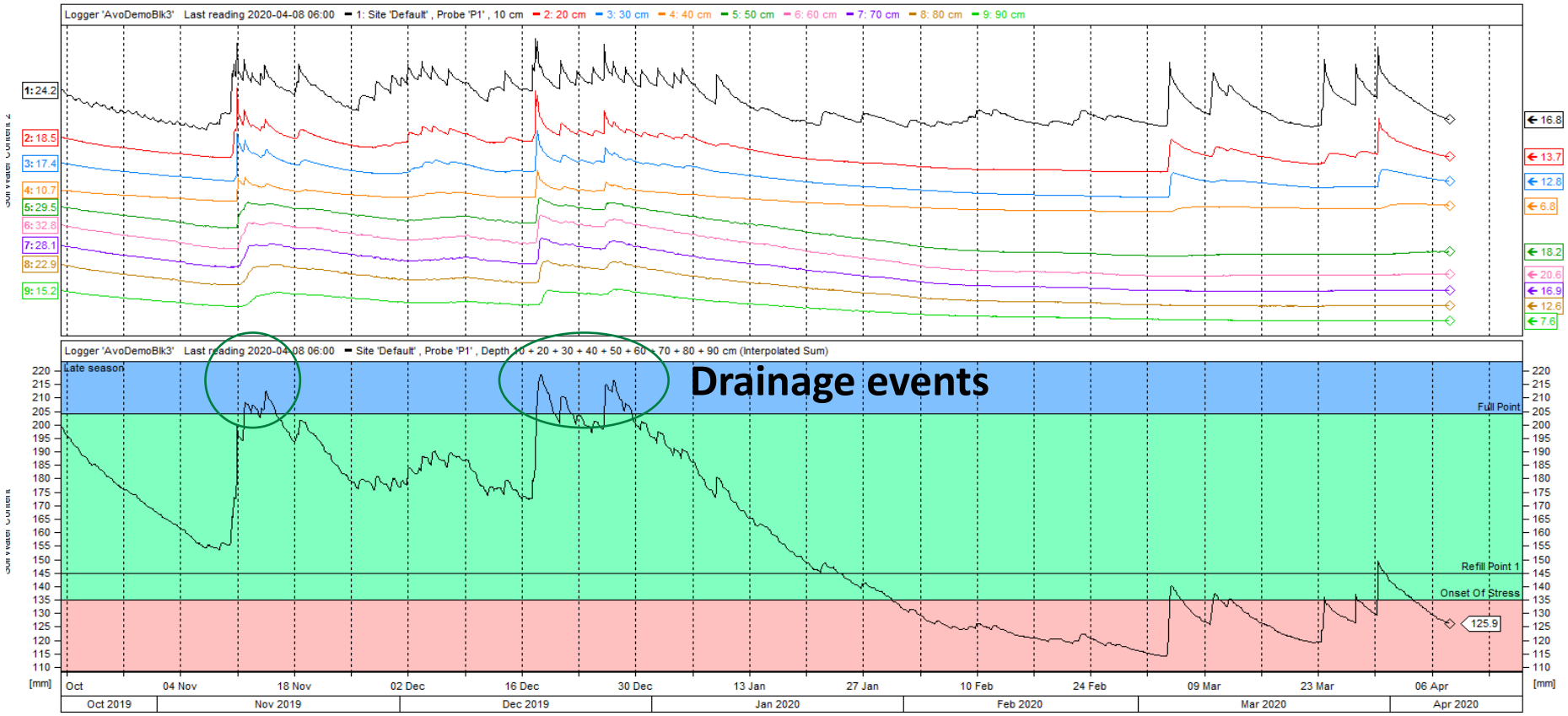


- **Select products that are lower risk such as N-Protect (lower risk of Volatilisation)**

Practical things to help reduce nutrient losses

- ***Most nutrient losses occur due to drainage or overland flow events.***

Water budgeting – keep a soil moisture budget



Practical things to help reduce nutrient losses

- ***Most nutrient losses occur due to drainage or overland flow events.***

- Soil test every paddock & before every crop (and well before planting)
- Look and monitor soil nutrient trends over time (including organic C)
- Use certified nutrient advisors to help develop a nutrient programme
- Remember the 4R's
- Match nutrient applications to plant growth stage and plant requirements
- Split nutrient applications
- Calibrate application equipment regularly
- Lower soil temps = lower rates of Nitrogen
- Avoid hot windy periods when surface applying urea (incorporate into soil)
- Keep a soil moisture budget (avoid excess irrigation)
- Minimise fallow periods
- Minimise cultivation (use precision ag practices where practical)
- Avoid surface run-off