2023 AIR EP MEMBER DAY

AIR EP
Ag Innovation & Research
Eyre Peninsula

CROP NUTRITION
BACK TO BASICS

Prof Mike McLaughlin,
University of Adelaide

Prof Glenn McDonald,
University of Adelaide

Beth Humphris,
Elders Jamestown

WEDNESDAY 5 JULY
Wudinna

THURSDAY 6 JULY
Cummins

Catering provided by Cummins District & Pt Lincoln Community Banks

Bendigo Bank

Contents

Good resource: The GRDC published a Nitrogen reference manual that has a lot of technical information, but also includes some calculations related to N uptake and fertiliser rates.

https://grdc.com.au/resources-and-publications/all-publications/publications/2020/a-nitrogen-reference-manual-for-the-southern-cropping-region

Program

Wudinna 5 July 2023

TIME	TOPIC	SPEAKER
1:00pm	Regos + coffee	
1:30pm	Welcome	AIR EP rep
1:35pm	Intro speaker	Chris Miller, Rural/Bendigo Bank
1:40pm	Soil nutrition	Mike McLaughlin, Uni of Adelaide
2:40pm	AFTERNOON TEA	
3:05pm	Intro speaker	Chris Miller, Rural/Bendigo Bank
3:10pm	Plant nutrition	Glenn McDonald, Uni of Adelaide
4:10pm	Intro speaker	Chris Miller, Rural/Bendigo Bank
4:15pm	Precision ag	Beth Humphris, Elders
5:15pm	Evaluation + close	Naomi Scholz, AIR EP
5:25pm	DRINKS AND NIBBLES	

Cummins 6 July 2023

TIME	TOPIC	SPEAKER
8:15am	Regos + coffee	
8:45am	Welcome	AIR EP rep
8:50am	Intro speaker	Chris Miller, Rural/Bendigo Bank
8:55am	Soil nutrition	Mike McLaughlin, Uni of Adelaide
10:00am	MORNING TEA	
10:25am	Intro speaker	Chris Miller, Rural/Bendigo Bank
10:30am	Plant nutrition	Glenn McDonald, Uni of Adelaide
11:30am	Intro speaker	Chris Miller, Rural/Bendigo Bank
11:35am	Precision ag	Beth Humphris, Elders
12:35pm	Evaluation + close	Naomi Scholz, AIR EP
12:45pm	LUNCH	

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WHO IS AIR EP

AIR EP
Ag Innovation & Research
Eyre Peninsula

Agricultural Innovation & Research Eyre Peninsula (AIR EP) was officially incorporated on 26 May 2020, with the aim of creating a single entity for farmer driven applied research, local validation and extension of agricultural technologies and innovations on the Eyre Peninsula. The AIR EP Board provides governance oversight and sets the strategic direction for the organisation.

THE BOARD

Chair
Bill Long

Public Officer
Greg Scholz

Greg Arthur

Ken Webber

Andrew Polkinghorne

Special Skills
Mark Stanley

Daniel Adams

Matthew Cook

WHAT WE DO

- Attract investment in research, development and extension relevant to EP farmers.
- Deliver workshops and events to increase knowledge and skills of farmers and advisors.
- Support farmers to participate in agricultural RD&E.
- Work closely with research providers and leading consultants and advisors to improve farm profitability.

HOW TO GET INVOLVED

- Become a member
- Subscribe to our electronic newsletter
- Nominate to the Board or Committees

For a full list of current projects visit the AIR EP website

www.airep.com.au

The Board is supported by two RD&E Committees, one with a focus on the medium rainfall zone (lower EP) and one on the low rainfall zone (upper EP). These committees focus on setting priorities for RD&E investment in the region, reviewing projects and providing input into events for farmers.

LOW RAINFALL RD&E COMMITTEE

Symon Allen (Chair)
Andy Bates
Rhiannon Schilling
Amanda Cook
Daniel Bergmann
Matthew Cook
Rhys Tomney
Andrew Ware
Leigh Scholz
Kevin Dart
Chris Lymn

MEDIUM RAINFALL RD&E COMMITTEE

Daniel Adams (Chair)
David Davenport
Dustin Parker
Billy Pedler
George Pedler
Jacob Giles
Denis Pedler
Lochie Siegert
Brett Masters
Daniel Puckridge
Nick Gale

MEET THE STAFF

AIR EP
Ag Innovation & Research
Eyre Peninsula

Executive Officer
Naomi Scholz

Finance Officer
Alanna Barns

Reginal Agriculture Landcare Facilitator (RALF)
Amy Wright

Sustaintable Agriculture Officer
Josh Telfer

Project Officer
Rebekah Fatchen

Speakers

Prof. Mike McLaughlin

Mike McLaughlin is a Professor in the School of Agriculture Food and Wine and Director of the Mosaic-sponsored University of Adelaide Fertiliser Technology Research Centre (http://www.adelaide.edu.au/fertiliser/). Mike gained his B.Sc. from the University of Ulster in Northern Ireland, a M.Agr.Sc from the University of Reading in England and his Ph.D. from the University of Adelaide. Mike's research interests are in soil/fertilizer chemistry and crop nutrition. He has authored and co-authored a copious number of high-quality papers around soil nutrients, fertilisers and agronomy. He lectures at the University of Adelaide as well as being a Science Fellow at the CSIRO. He has been on the GRDC Southern panel, as well as writing numerous publications for GRDC and other bodies. He is imminently qualified to speak on the topic of phosphorous and trace elements and well as many others.

Prof. Glenn McDonald

Glenn has had a long and distinguished career at the University of Adelaide since 1987. He has an extensive lecturing, research and administration career. He has authored and co-authored a plethora of papers and articles, as well as being involved in numerous industry RD&E projects and roles including being a Board member of EPARF, a forerunner of AIR EP. He describes himself as a "generalist with broad interests spanning agronomy, crop physiology and crop nutrition". However, the output from this 'generalist' has allowed him to speak with authority on a range of topics included those that he has been asked to present on today.

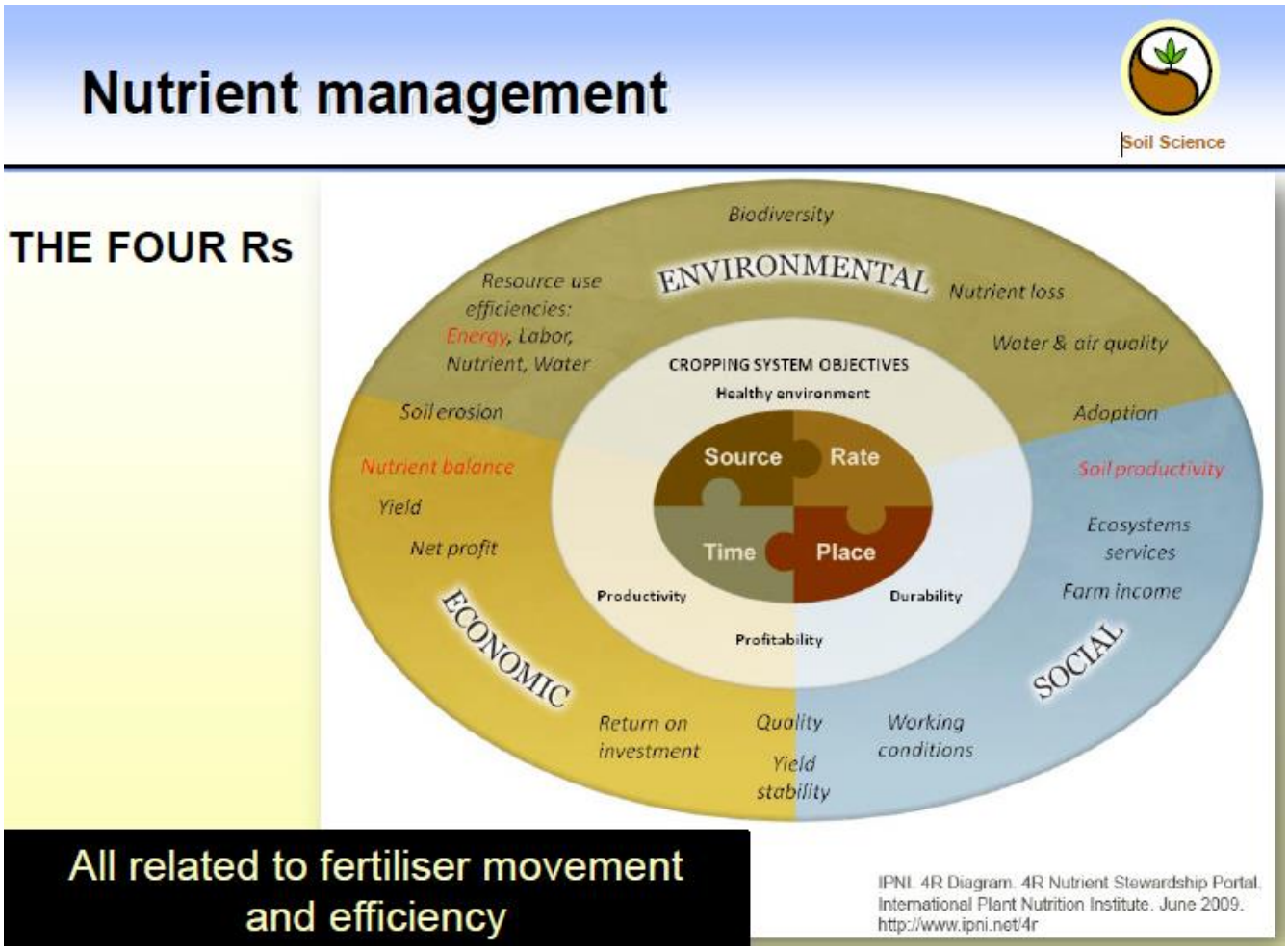
Beth Humphris, Agronomist & Soil Consultant, Elders

Beth loves being part of the farming lifestyle and working alongside growers to maximize profits. She enjoys the diversity of her role, working both in the agronomy and soil science fields. Beth has a strong passion for the field of soil sciences and precision agriculture, using this in her everyday agronomy or as a fee for service offering to non-agronomy clients. In her spare time, Beth likes to help her dad and husband on the family farms, volunteering with Upper North Farming Systems group and the Society of Precision Agriculture. She also enjoys running.

Speaker contact list

Glenn McDonald	University of Adelaide	8303 7358
Mike McLaughlin	University of Adelaide	0409 693 906
Beth Humphris	Elders	0418 327 460

Mike McLaughlin: Behaviour of fertilisers in soils



Nutrient removal - macronutrients

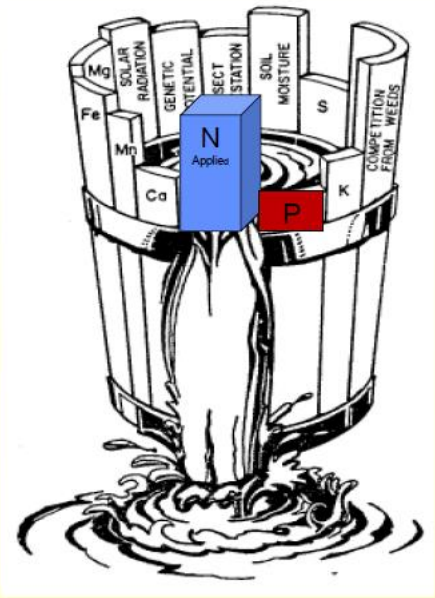
Soil Science

Crop	N	P	S	K	Cu	Zn	Mn
	kg / tonne grain				g / tonne grain		
Wheat	23	3	1.5	4	5	20	40
Faba bean	41	4	1.5	10	10	28	30
Canola	41	7	10	9	4	40	40
Barley	20	2.7	1.5	5	3	14	11
Lucerne (hay)	33	3	2.4	28	6	21	56

- N is required in greatest quantities, then K, P & S.
- Some crops require twice as much N as others.

Least limiting nutrient

Soil Science



- Yield determined by nutrient most limiting
- Correction of secondary issues required for maximum yield, i.e. if N becomes sufficient then more P may be required for maximum yield.

Macronutrient mobility

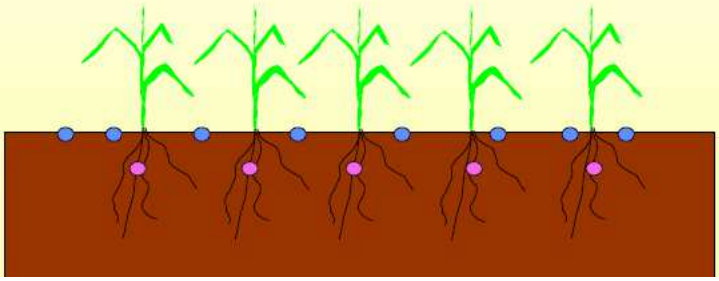
Soil Science

- Managing N, P, and K mobility in soils (ease of movement with water) is most important
- On scale of 1 (immobile) to 10 (moves with water)
  - Nitrate-N (NO_3^-) = 10 (mobile)
  - Ammonium-N (NH_4^+) = 3
  - Potassium (K^+) = 3
  - Phosphate ($H_2PO_4^-$) = 1 (immobile)
- Dependent on soil type
- Sulfate (SO_4^{2-}) ions are held by electrostatic charges, so they are not held as tightly as phosphate – more like nitrate

Form of nutrient addition

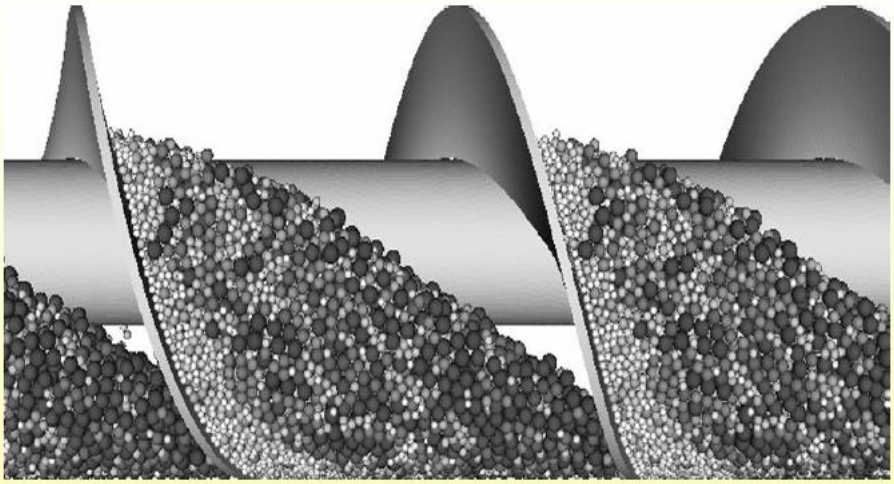
Soil Science

- SOLID GRANULES (TOPDRESS, BAND)
  - -Often cheaper to transport
  - -Blends also used but can separate out
- LIQUID (FOLIAR, FERTIGATE, BAND, DRIBBLE)
  - -Flexibility in the mix (micros, pesticides)



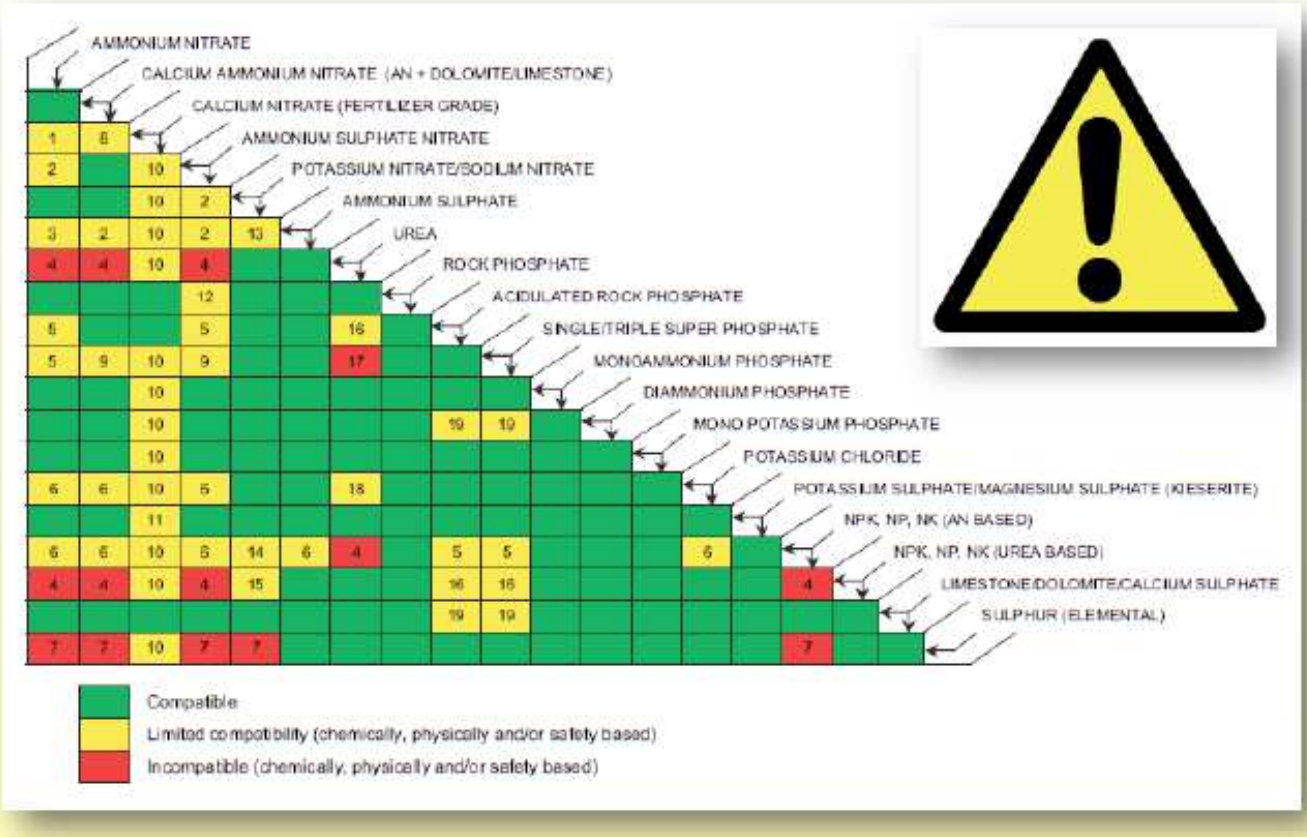
Segregation in bulk blends

Soil Science



Beware compatibility in blends

Soil Scie



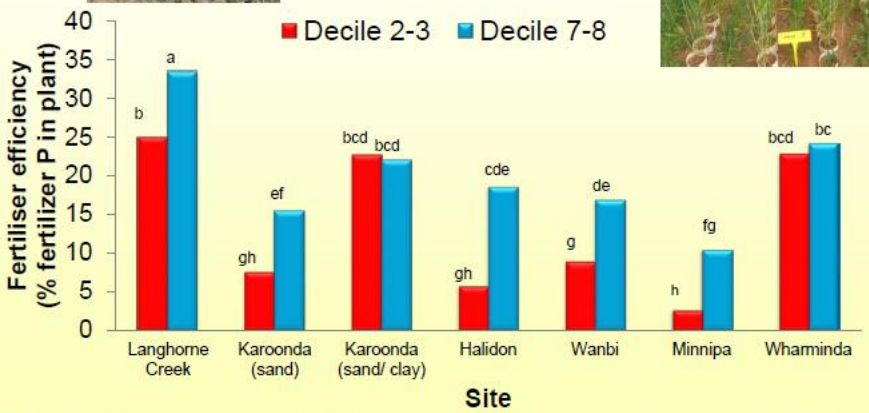
Phosphorus

Soil Science

- Current plant utilisation efficiency of phosphate fertilisers (first year) is 5-25% under Australian conditions, so a lot of P builds up in soil – this reduces over time as P fertility is increased
- Residual value of P must be considered in efficiency calculations – P is actually not used that inefficiently in agriculture in non-calcareous soils
- Calcareous soils are a problem in that P fixation is strong and residual value is lower than non-calcareous soils

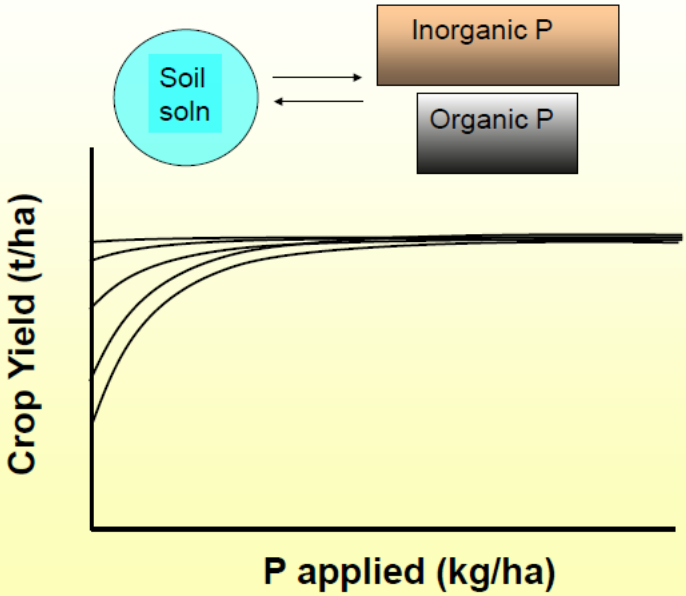
In low P soils, initial P efficiency is low

Soil Science



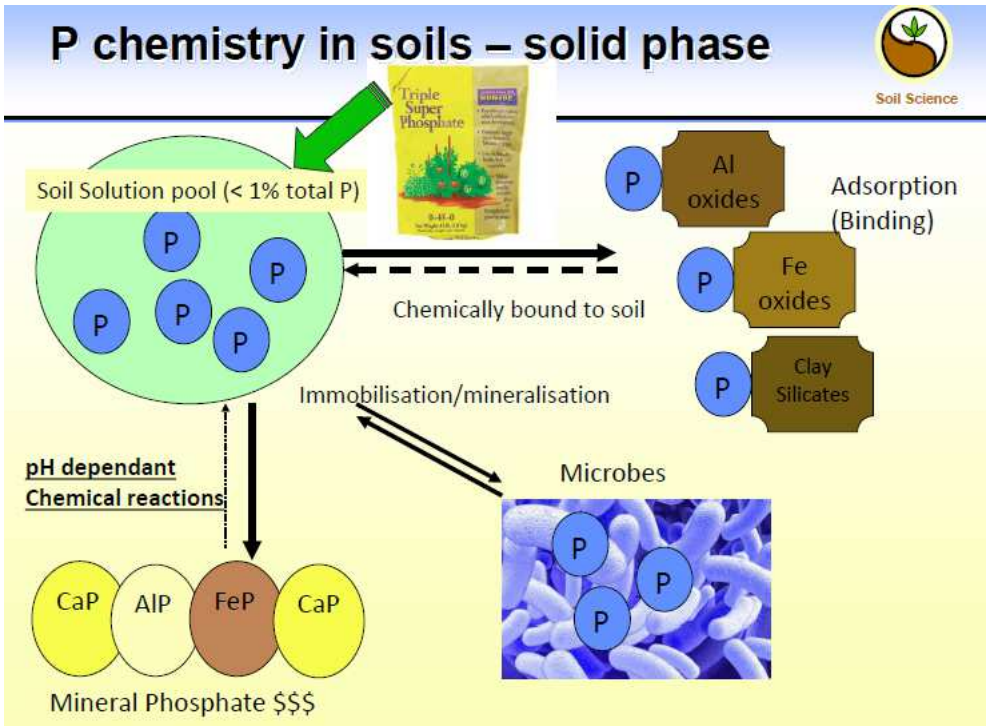
McBeath, T.M., McLaughlin, M.J., Kirby, J., and Armstrong, R.D. 2012. The effect of soil water status on fertiliser, topsoil and subsoil phosphorus utilisation by wheat. Plant Soil (in press).

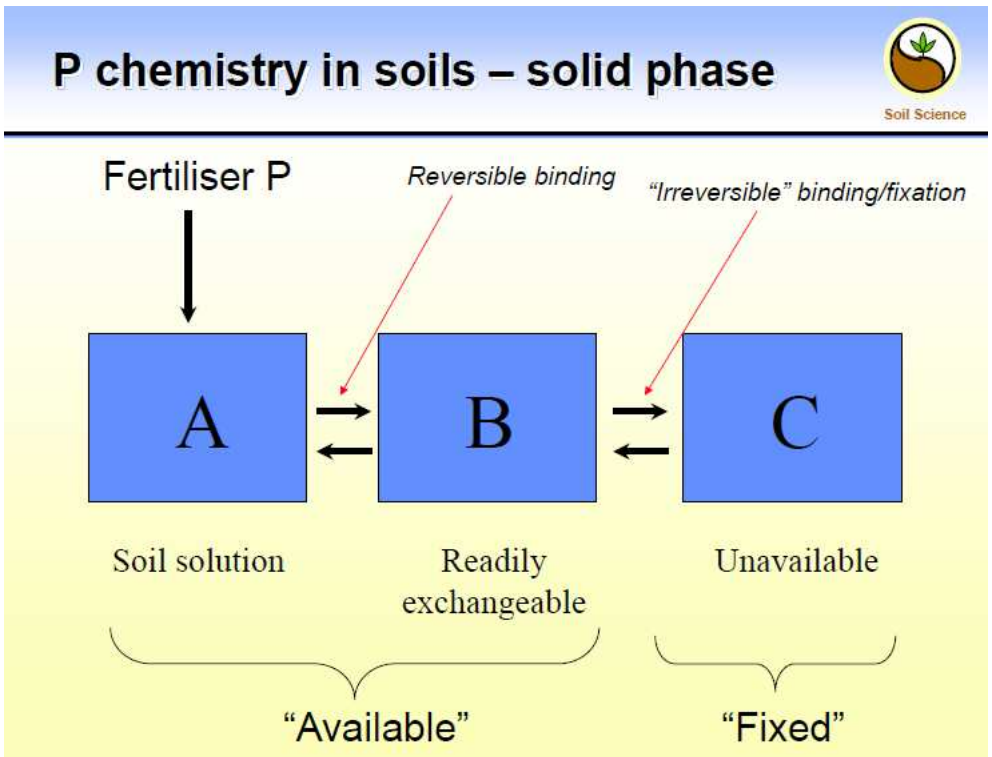
Crop P responses to P over time



Placement – P

- P movement is limited by diffusion (controlled by soil Ca, Fe, Al)
- Early in the season plant roots have easier access to P when banded (in most soils)
- Banding can result of stratification of P in the topsoil which can be prone to drying, especially in reduced till systems
- In higher production systems, incorporated broadcasting (Mallarino et al. 2001) or deep applications of P (Bell et al. 2009) have been suggested to maintain fertility, and decrease vertical stratification


P chemistry in soils – solid phase
Soil Science
Triple Super Phosphate
Soil Solution pool (< 1% total P)
P
Al oxides
Adsorption (Binding)
Fe oxides
Clay Silicates
Chemically bound to soil
Immobilisation/mineralisation
Microbes
pH dependant Chemical reactions
CaP
AlP
FeP
CaP
Mineral Phosphate $$$


P chemistry in soils – solid phase
Soil Science
Fertiliser P
Reversible binding
"Irreversible" binding/fixation
A
B
C
Soil solution
Readily exchangeable
Unavailable
"Available"
"Fixed"

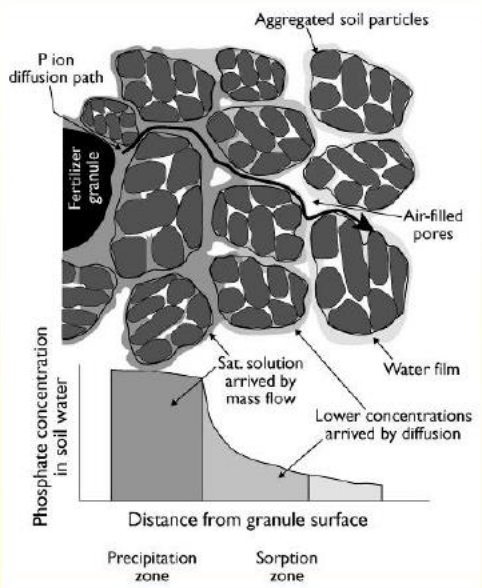
Reactions that reduce effectiveness

Soil Science

- Strong adsorption (less-reversible binding)
- Precipitation (or lack of dissolution)
- Inaccessibility (physical)
- Leaching
- Erosion
- Crop uptake (for following crops)

P chemistry around granules

Soil Science



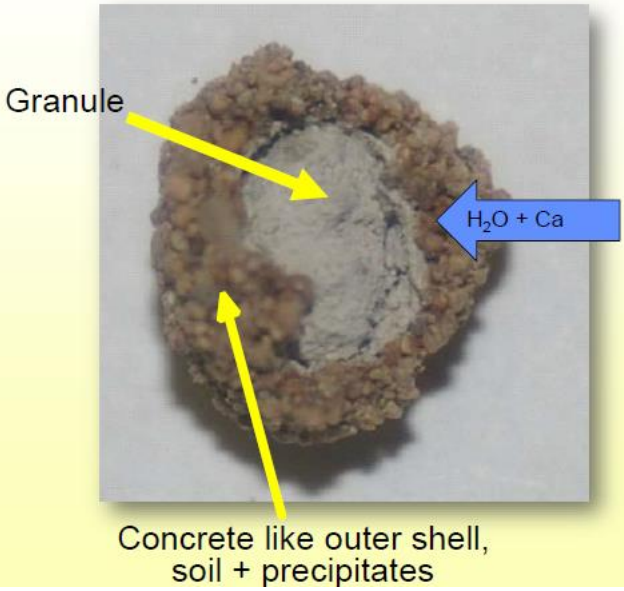
Efficiency of fluid and granular P in calcareous soils

Soil Science

- Granular fertilisers act like a "sponge" soaking up Ca from soil solution and causing the P to revert to less soluble minerals in the granule

Fertiliser granule after 5 weeks

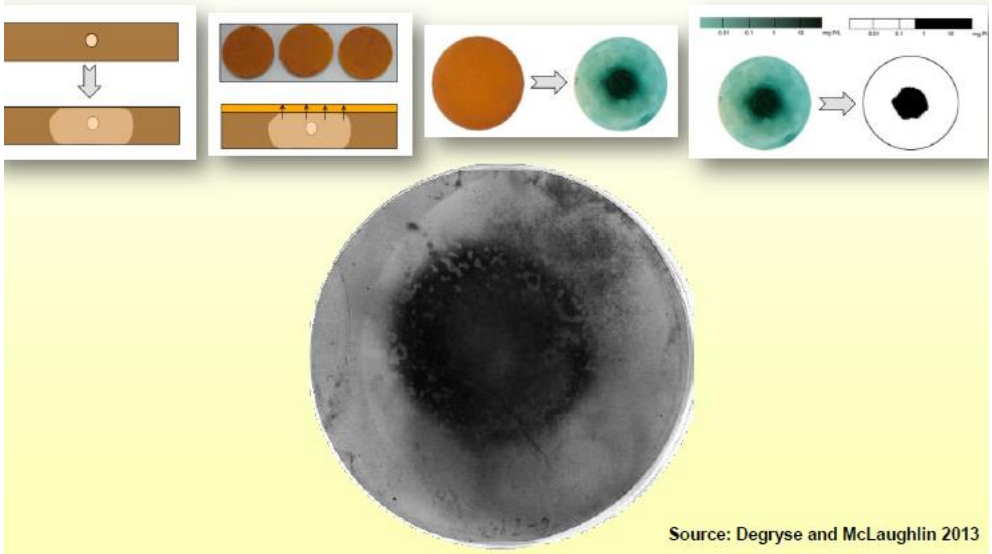
Soil Science



Why is P diffusion from granule important? Broadcast vs banding vs deep placement

Soil Science

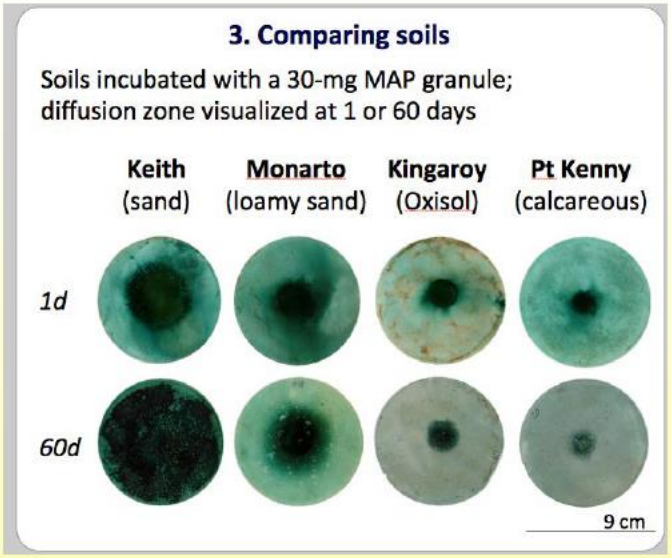
P diffusion from granules – "visualisation technique"



Source: Degryse and McLaughlin 2013

Why is P diffusion from granule important? Broadcast vs banding vs deep placement

Soil Science



Source: Degryse et al 2016

Improving fertiliser P efficiency

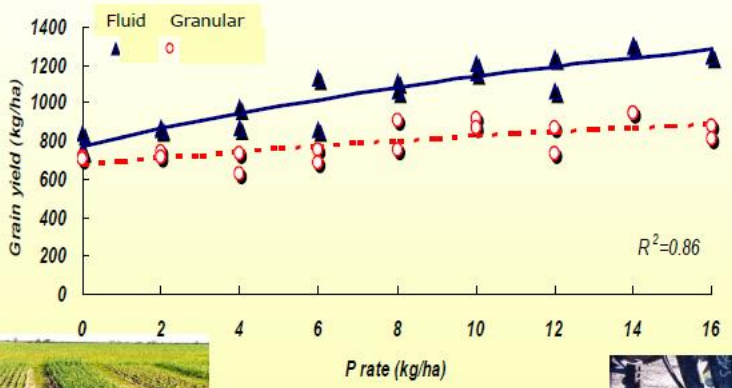
Soil Science

Improving fertiliser P efficiency

Soil Science

Emerald Rise 2002 - Krichauff wheat

8.6% $CaCO_3$ 38 mg/kg Colwell P



Fluids field trial data 1998-2003

Soil Science

SOIL TYPE	Comparisons	Yield +	Yield -	No diff.
GREY CALCAREOUS	*50*	90%		10%
RED CALCAREOUS	*40*	60%		40%
RED LOAMY SAND	*11*		36%	64%

68 yield increases

4 yield decreases

29 no significant differences

(Holloway et al., 2001)

Fluid P

Soil Science

- Fluids equal or better (per unit P) than granular fertilisers as P sources across a wide range of soils (rarely worse)
- Highest likelihood of better agronomic performance on calcareous soils
- Fluids offer formulation flexibility
- BUT - costs per unit P still higher than granular fertilisers plus remember to factor in equipment set up costs!

Soil testing for P

Soil Science

Three main indices you should know

- Colwell P – P extracted by a dilute sodium bicarbonate solution
- PBI – P buffer index – how much P the soil binds from a solution containing P
- DGT – "diffusive gradients in thin films" – how much P is captured by a membrane simulating a plant root

Typical soil test result

Soil Science

eurofins | APAL

SOIL ANALYSIS

AGRONOMY SOLUTIONS
RESEARCH • EDUCATION • ADVICE

Agent:	Agronomy Solutions	Report Date:	28/06/2023
Agent Address:	Unit 3 / 11 Ridley Street, HINDMARSH, SA, 5007	Sampling Date:	NA
Client:	EPARF/Minnipa - GRDC Project	Date Received:	23/03/2020
Test Set or Quotation:	GRDC 0-10	Sample Name:	105
Barcode:	110558205	Crop:	Wheat
Batch Number:	16025	Sample Depth:	0-10
Submission ID:	48717	GPS Start:	NA
		GPS End:	NA

	Analyte	Unit	Desired Level	Level Found	c.mol/kg	Very Low	Low	Acceptable	High	Excessive
	MIR - Aus Soil Texture			Sand						
	Organic Carbon (W&B)	% (40°C)	0.50-1.00	0.61						
	pH 1:5 water	pH units	6.50-7.50	7.84						
	pH CaCl2 (following 4A1)	pH units	5.50-6.50	7.15						
Extracted N-P-K-S	Nitrate - N (2M KCl)	mg/kg	10-50	14						
	Ammonium - N (2M KCl)	mg/kg	2.0-10	3.8						
	Colwell Phosphorus	mg/kg	10-20	12						
	DGT-P	µg/L	67-100	98						
	PBI + Col P		35-70	13						
Other tests	Gravimetric moisture (as received)	%		<0.8						
Salt	Chloride	mg/kg	15-400	13						
	Salinity EC 1:5	dS/m	0.025-0.60	0.12						
Al	CaCl2 extr. Aluminium	mg/kg	0.5-5.0	<0.1						
Physical	MIR - Clay	%		1.5						
	MIR - Sand (>20 micron)	%		95.7						
	MIR - Silt (2-20 micron)	%		2.9						

NOTE: Eurofins APAL will review published literature for crop desired levels, and reserves the right to make changes to this information in test reports as and when these reviews are conducted.

"Good" area

Courtesy Sean Mason, Agronomy Solutions

Typical soil test result

Soil Science

eurofins | APAL

SOIL ANALYSIS

AGRONOMY SOLUTIONS
RESEARCH • EDUCATION • ADVICE

Agent:	Agronomy Solutions	Report Date:	28/06/2023
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Client:	EPARF/Minnipa - GRDC Project	Date Received:	23/03/2020
Test Set or Quotation:	GRDC 0-10	Sample Name:	109
Barcode:	1100658209	Crop:	Wheat
Batch Number:	16625	Sample Depth:	0-10
Submission ID:	48717	GPS Start:	NA
		GPS End:	NA

	Analyte	Unit	Desired Level	Level Found	c.mol/kg	Very Low	Low	Acceptable	High	Excessive
	Mill - Aus Soil Texture			Sandy loam						
	Organic Carbon (W&B)	% (40°C)	0.70-1.40	1.59						
	pH 1:5 water	pH units	6.50-7.50	8.43						
	pH CaCl2 (following 4A1)	pH units	5.50-6.50	7.86						
Extractable N-P-K-S	Nitrate - N (2M KCl)	mg/kg	10-50	26						
	Ammonium - N (2M KCl)	mg/kg	2.0-10	3.7						
	Colwell Phosphorus	mg/kg	29-36	21						
	DGT-P	ug/L	67-100	31						
	PBI + Col P		35-70	100						
Other tests	Gravimetric moisture (as received)	%		4.6						
Salt	Chloride	mg/kg	15-600	180						
	Salinity EC 1:5	dS/m	0.025-0.60	0.29						
N	CaCl2 extr. Aluminium	mg/kg	0.5-5.0	<0.1						
Physical	Mill - Clay	%		11.8						
	Mill - Sand (+20 micron)	%		77.5						
	Mill - Silt (2-20 micron)	%		10.7						

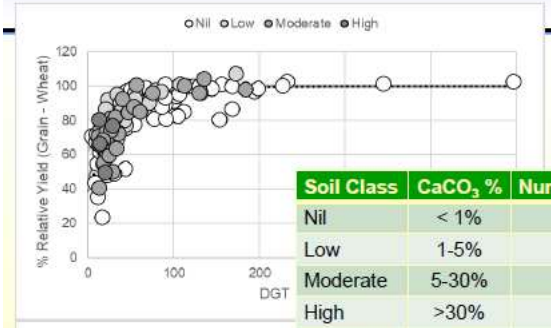
NOTE: Eurofins APAL will review published literature for crop desired levels, and reserves the right to make changes to this information in test reports as and when these reviews are conducted.

"Poor" area

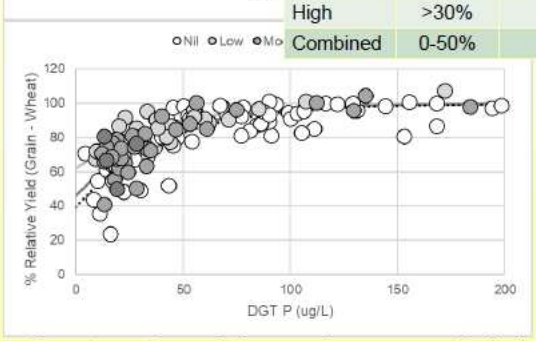
Courtesy Sean Mason, Agronomy Solutions

DGT calibrations – Wheat (2006-2021)

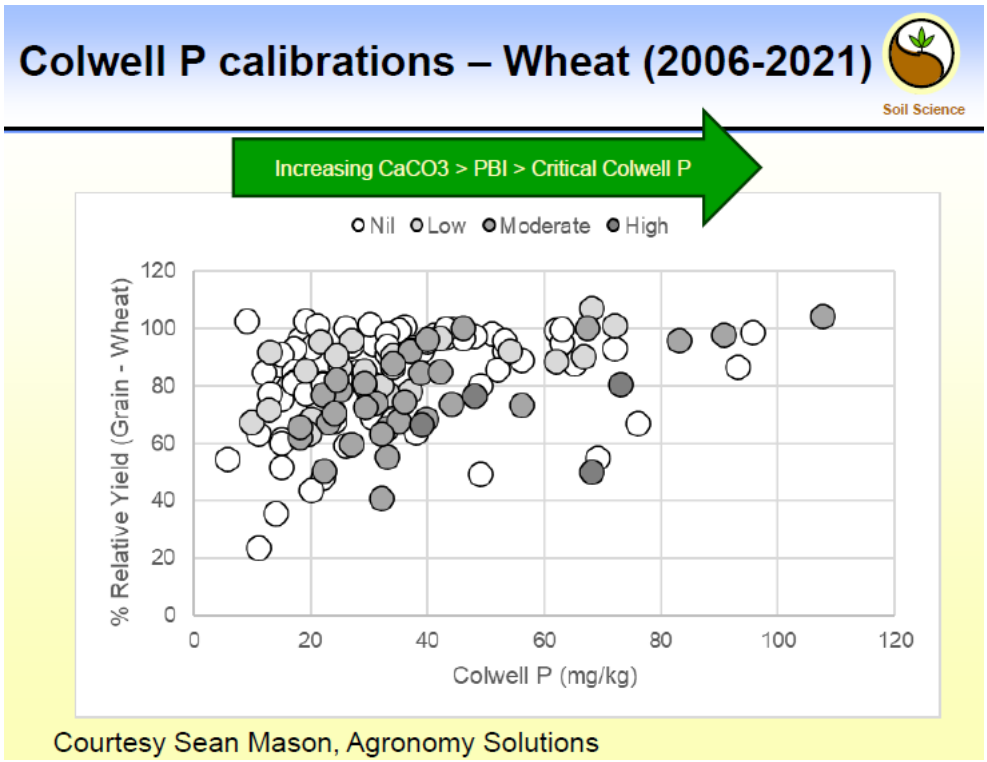
Soil Science

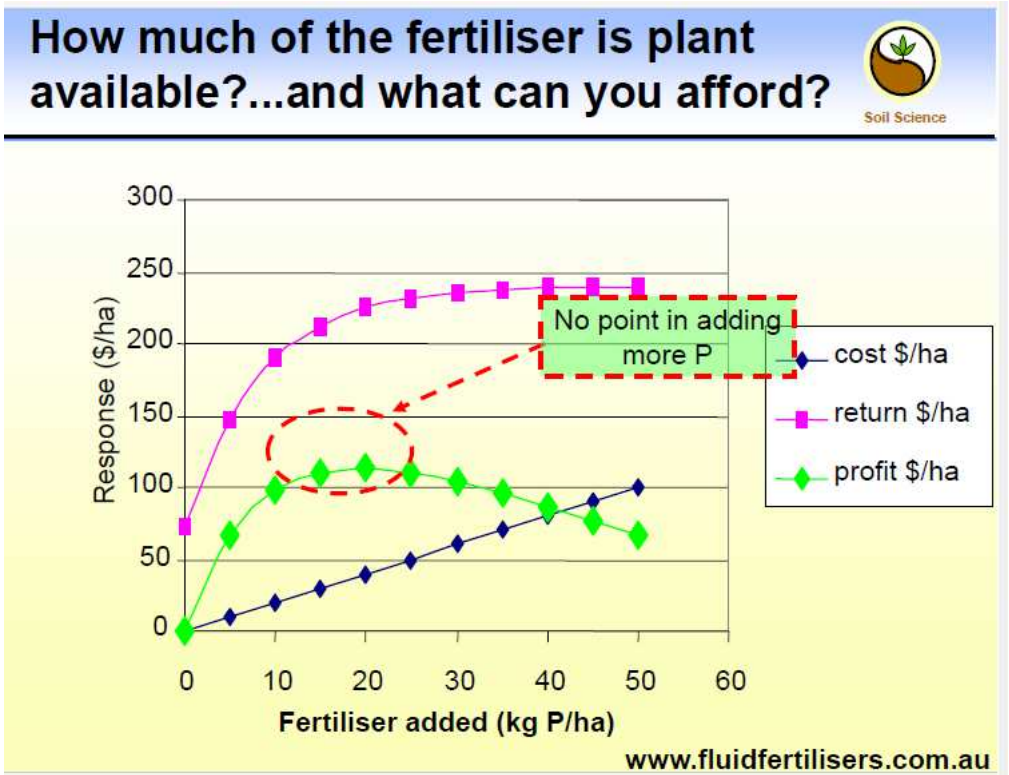


Soil Class	$CaCO_3$ %	Number of trials	DGT R^2	DGT Critical (90%) ug/L
Nil	< 1%	80	0.69	71
Low	1-5%	22	0.62	52
Moderate	5-30%	35	0.64	64
High	>30%	4	-	-
Combined	0-50%	141	0.63	66 (58-77) 95% CI



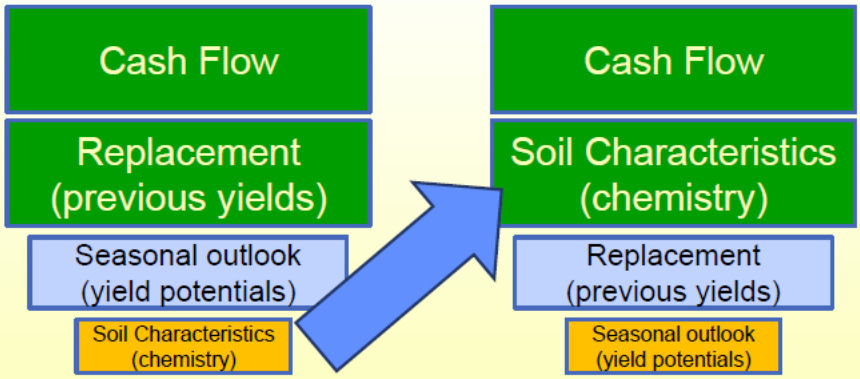
Courtesy Sean Mason, Agronomy Solutions


Colwell P calibrations – Wheat (2006-2021)
Soil Science
Increasing CaCO3 > PBI > Critical Colwell P
Nil
Low
Moderate
High
% Relative Yield (Grain - Wheat)
Colwell P (mg/kg)
Courtesy Sean Mason, Agronomy Solutions


How much of the fertiliser is plant available?...and what can you afford?
Soil Science
Response ($/ha)
Fertiliser added (kg P/ha)
No point in adding more P
cost $/ha
return $/ha
profit $/ha
www.fluidfertilisers.com.au

What drives P input decisions?

Soil Science



Courtesy Sean Mason, Agronomy Solutions

Improving P fertiliser efficiency

Soil Science

Lower solubility compounds where P leaching a problem

- Reverted superphosphate, partially acidulated rock phosphate

Microbial inoculants to release fixed P

- Few that actually work in the way claimed

Polymer coatings to reduce "fixation"

- Various formulations – usually ineffective

Rate/removal – micronutrients/trace elements (TEs)

Soil Science

Crop	N	P	S	K	Cu	Zn	Mn
	kg / tonne grain				g / tonne grain		
Wheat	23	3	1.5	4	5	20	40
Faba bean	(41)	4	1.5	10	10	28	30
Canola	41	7	10	9	4	40	40
Barley	20	2.7	1.5	5	3	14	11
Lucerne (hay)	(33)	3	2.4	28	6	21	56

Micronutrients/trace elements (TEs)

Soil Science

Essentials:

B, Cl, Cu, Fe, Mn, Mo, Ni, Zn

Other elements:

Co, Si, Se, I, V, Na

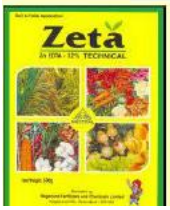
Examples of common TE fertilisers

Soil Science

TE co-granulated NPK fertilizers e.g. MAP, DAP

or fluids e.g. APP

Bulk blends with NPK fertilizers



TE chelates for foliar or fertigation

TE powders

Distribution in field important for root access

Soil Science

- Assuming normal granule size and broadcast at 2 kg Zn/ha (heptahydrate), there would be about **22 Zn granules/m²** soil - **unlikely plant roots would "find" this Zn easily**

Bulk blend

O NPK ● Zn

Compound

O NPK+ Zn

- Assuming normal granule size, 1% Zn in granule and broadcast at 2 kg Zn/ha, there would be about 500 Zn **granules/m²** soil - **much more likely plant roots would "see" this Zn**

Co-granulated TE products better than bulk blends

Soil Science

Visualisation of fertiliser Zn dissolution in soil form of NP fertiliser important for Zn diffusion

Soil Science

Acid soil

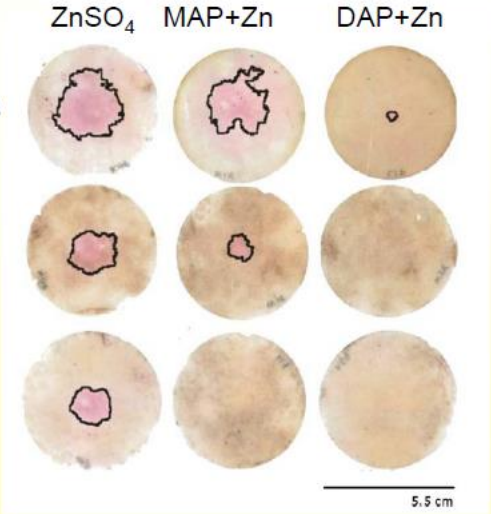
$ZnSO_4$ = MAP+(1%)Zn > DAP+(1%)

Neutral soil

$ZnSO_4$ = MAP+Zn > DAP+Zn

Calcareous soil

$ZnSO_4$ > MAP+Zn = DAP+Zn

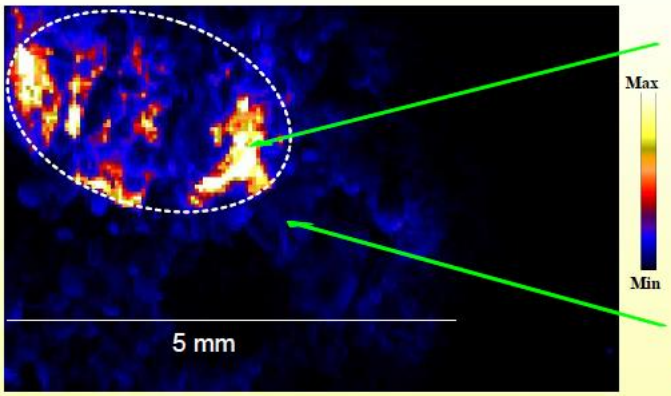


Source: Degryse et al. (2014)

Zn map of fertiliser dissolution in soil

Soil Science

After 5 weeks incubation in soil



Zinc in granule only slowly dissolves and moves out of granule

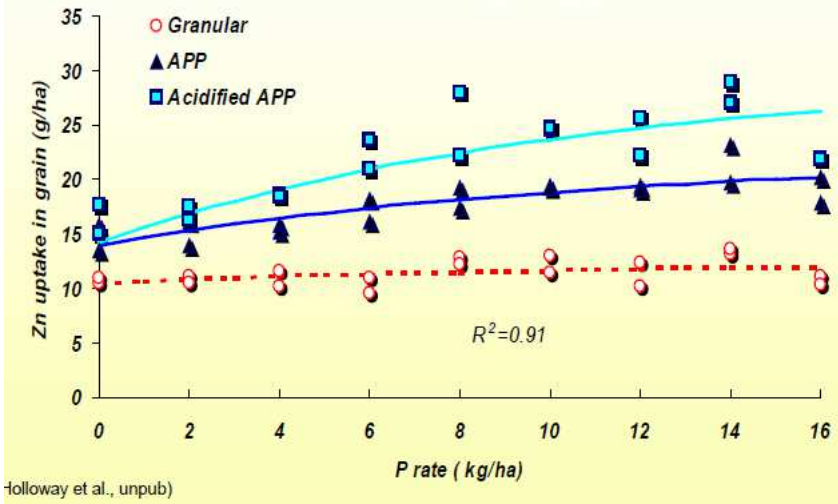
Zn silicate (Zn_2SiO_4) forms in soil

Granular TE fertilisers

Soil Science

- A range of products are available – immediate availability and crop response will be related to water soluble TE in the product
- Non-water soluble TE will only be slowly available to crops – provides residual value
- For TE-enriched granular P fertilisers don't worry about the form of TE in the product – they all end up the same in soil
- There is nothing special about humates or "nano" (except higher costs)
- Fluid TEs (soil applied) perform well in highly calcareous soils

Field fluid fertiliser trial data – Zn uptake



Holloway et al., unpub)

Foliar TE fertilisers

- A range of products are promoted – sulfates, oxysulfates, chelates, humates, etc.
- Yield responses to foliar Zn are <u>not always consistent</u> and there is not strong evidence that one form is more effective over another
- Chelates generally are more expensive than sulfates or oxysulfates
- There is nothing special about humates or fulvates – synthetic chelates are generally much more effective in complexing TEs

Trace element management

Soil Science

- Soil testing for trace elements is not worth it – use tissue testing instead (for foliar application that year or soil application the following year)
- Trace elements have good residual value (up to 10 years or more) as export is low compared to fertilizer additions
- A lot of soils have now built up trace element fertility - we find it hard to find Zn deficient soils in SA for experiments!
- If the incremental cost of adding trace elements is small then worthwhile doing for "insurance" – only on alkaline soils though (pH>7.5). Not needed in more acidic soils.

Some thoughts

Soil Science

- Soil and plant testing are important bits of information in making a fertiliser decision (but maybe not the most important bits)
- Think about building P and TE fertility in low cost years (low fertiliser prices) as there is generally residual value that you can capture in high cost years (unfortunately less so for highly calcareous soils)
- Don't believe in magic and/or cheap products – there is always a reason why products work, why they are cheap, or why they are useless
- Think about spatial variability of fertility in the paddock and if management can be changed accordingly

https://sciences.adelaide.edu.au/fertiliser/

Getting the basics right – N and S Nutrition: Glenn McDonald

Getting the basics right – N and S nutrition

Glenn McDonald
School of Agriculture, Food and Wine
Waite Campus

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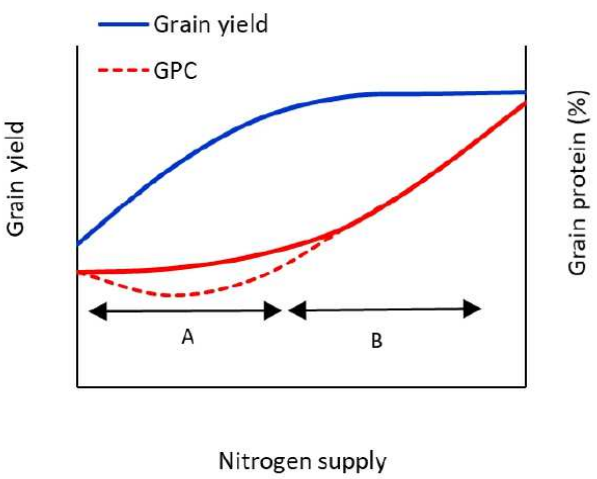
make history.

Responses to N supply in cereals



	Low yield	High yield
Low protein	N deficient	Low soil N Protein 'dilution' effect
High protein	Other factors limiting yield	Adequate soil N

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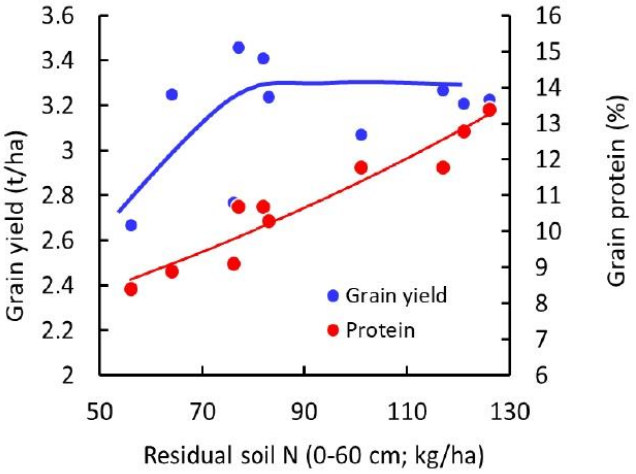
Rotation effects on yield and protein



- Increased frequency of pulses increased grain yield and protein
- The response followed the general response in yield and protein to increased N supply

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Brill et al (2013) GRDC Update, Coonabarabran

Nitrogen

Soil
- Mainly in soil OM – available through mineralisation
- Mainly taken up as nitrate (NO_3^-)
- Mobile in soil – vulnerable to leaching

Plant
- Amino acids and protein formation
- Mobile in plant – symptoms on old leaves
- High N makes S deficiency more pronounced
- Removal: 15-25 kg/t (cereals); 35-45 kg/t (canola)

Sulphur

Soil
- Mainly in soil OM – available through mineralisation
- Mainly take up as sulphate (SO_4^-)
- Mobile in soil – vulnerable to leaching

Plant
- Amino acids, protein lipid formation
- Immobile in plant – symptoms on young leaves
- Adequate S enhances N responses
- Removal: 1.2-2 kg/t (cereals); 3.5-4 kg/t (canola)

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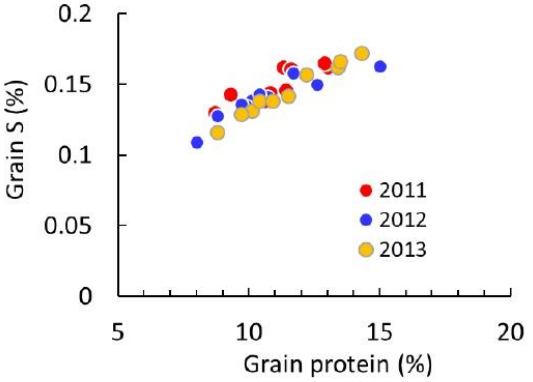
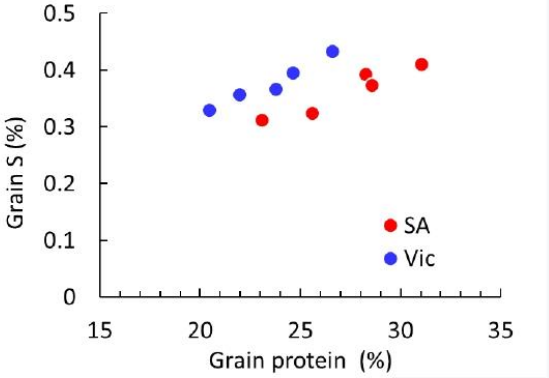
N and S are closely associated





N:S ratio = 12.1:1 to 13.8:1
Critical grain S >0.12%; N:S <16

N:S ratio: SA - 12:1; Vic – 10:1
Critical grain S > ~0.35%

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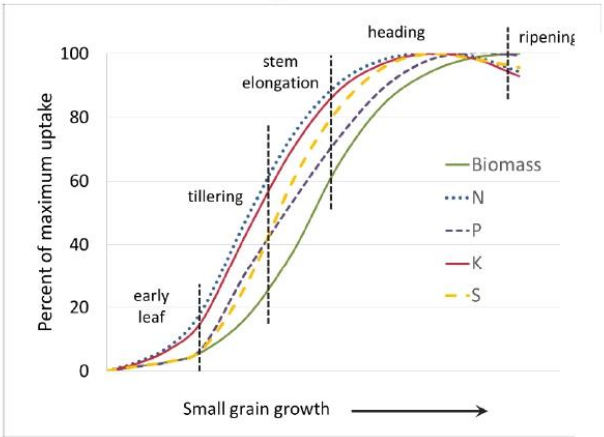
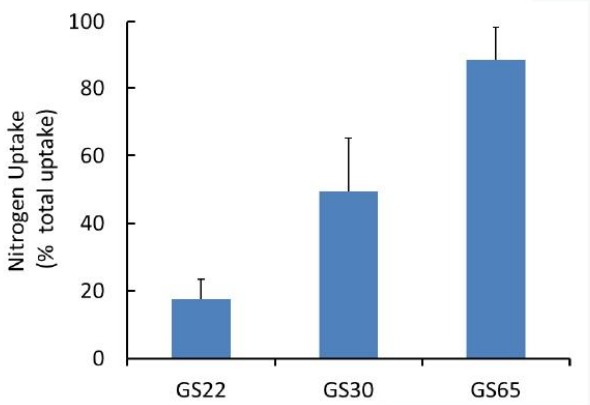
Nutrient uptake in wheat





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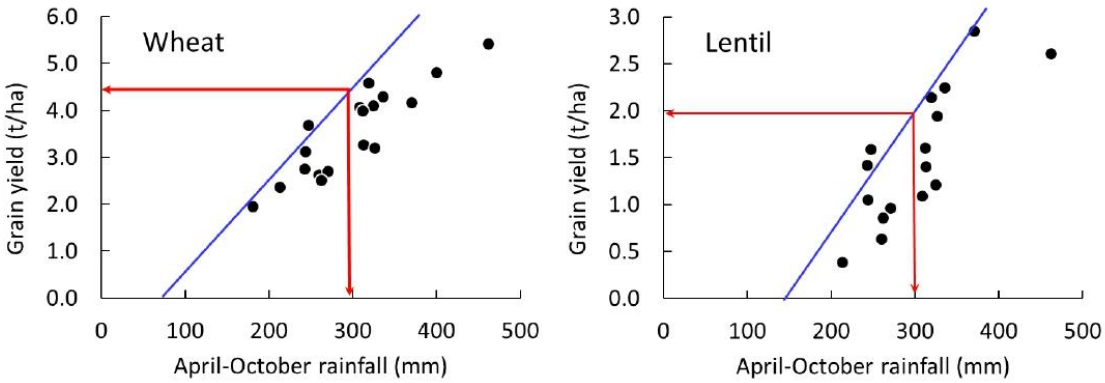
Setting a yield target

Setting a yield target – using historical yields

Roseworthy average farm yields 2005-2022



Setting a yield target – estimated available water

CROP WATER SUPPLY	Cummins (at 1 July)
¼ x November-March rainfall	97 mm
+	+
Rainfall since 1 April to present time	172 mm
+	+
Predicted rainfall to end October	191 mm
	387 mm
ESTIMATED YIELD (wheat)	
Potential GY (t/ha) = (CW-60) x 23x 0.001	Pot. GY = 7.53 t/ha
Estimated GY = 80% x Potential GY	Est GY = 6.02 t/ha

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Setting a yield target – estimated available water

CROP WATER SUPPLY	Wudinna (at 1 July)
¼ x November-March rainfall	146 mm
+	+
Rainfall since 1 April to present time	103 mm
+	+
Predicted rainfall to end October	128 mm
	268 mm
ESTIMATED YIELD	
Potential GY (t/ha) = (CW-60) x 23x 0.001	Pot. GY = 4.78 t/ha
Estimated GY = 80% x Potential GY	Est GY = 3.82 t/ha

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Setting a yield target – crop models

https://www.yieldprophet.com.au/yplite/

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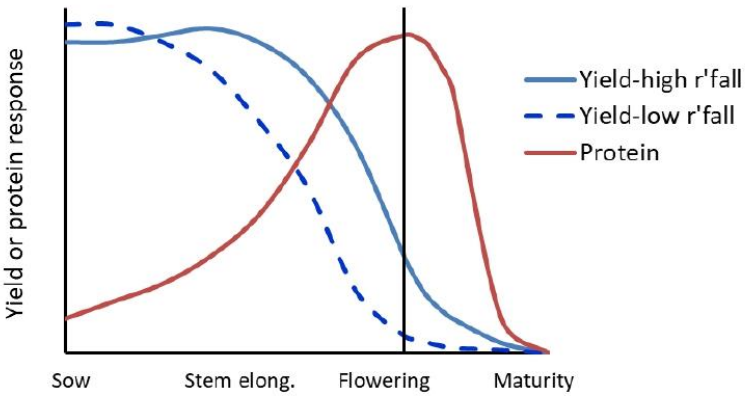
How does timing affect N responses?



Responses depend on

- Yield potential
- N supply later in the season and N stress
- Soil moisture at application

In general:

- Lower yield responses as N delayed during stem elongation
- Little to no yield benefit from N at flowering
- Increasing protein response with delayed application
- Greatest effect 3-4 weeks around flowering

Strong seasonal/site influence on the effect of timing

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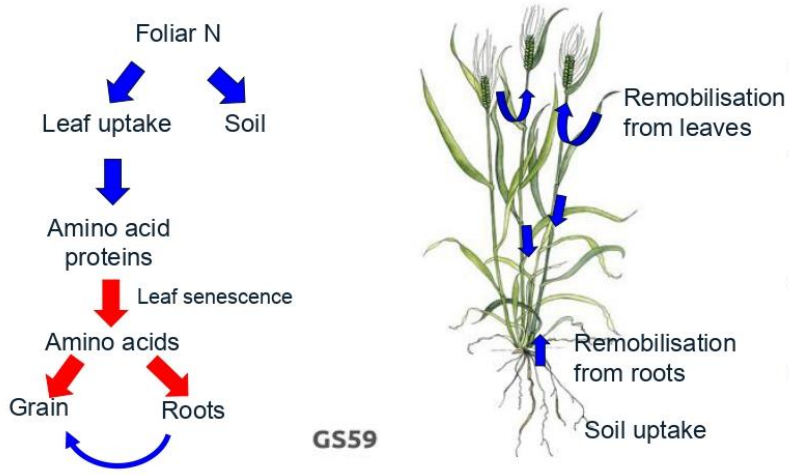
Foliar N applications for grain protein



- Foliar N can be effective in increasing grain protein
- N first incorporated into amino acids and proteins
- Photosynthesis drives the metabolism of N – healthy leaves important
- About ½ N remobilised from leaves moves directly to grain
- Recovery of foliar N in grain can be low

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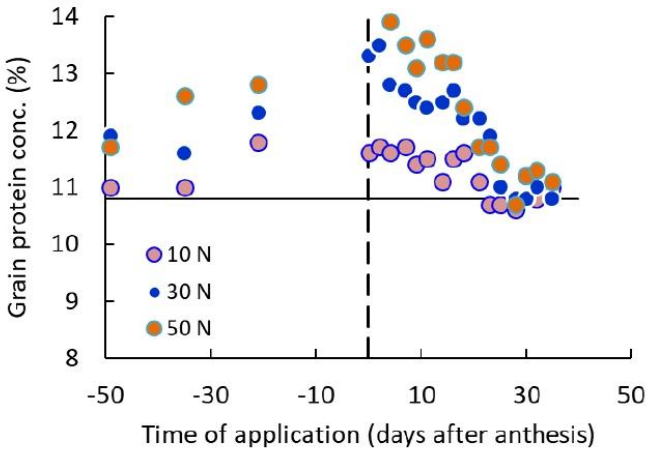
Timing of foliar N and grain protein



- Protein starts to accumulate early in grain development
- Require a pool of N in the plant before grain filling occurs
- Maximum response pre-flower and early grain fill
- Response to foliar N declines after the start of grain fill
- Effectiveness of earlier applications depends on N rate

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Estimated responses from foliar N

Target yield (t/ha)	N applied (kg/ha)	Proportion of applied N in the grain (%)		
		20	30	50
		Increase in grain protein (%)		
2.0	10	0.5	0.7	1.1
	15	0.7	1.0	1.7
	20	0.9	1.4	2.3
5.0	10	0.2	0.3	0.6
	15	0.3	0.5	0.9
	20	0.5	0.7	1.1

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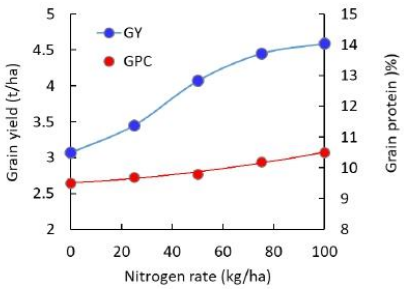
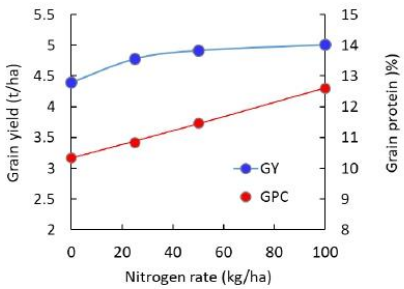
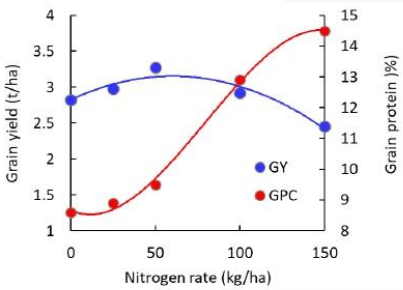
Yield and protein responses



Max yield at ~ 10-10.5% GPC



Max yield at ~ 10.5-11% GPC



Max yield at ~ 9% GPC

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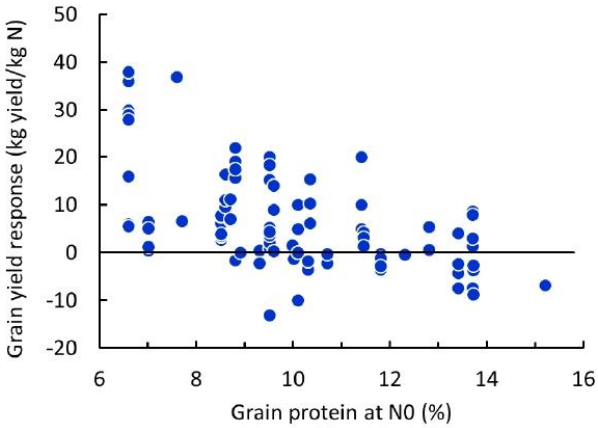
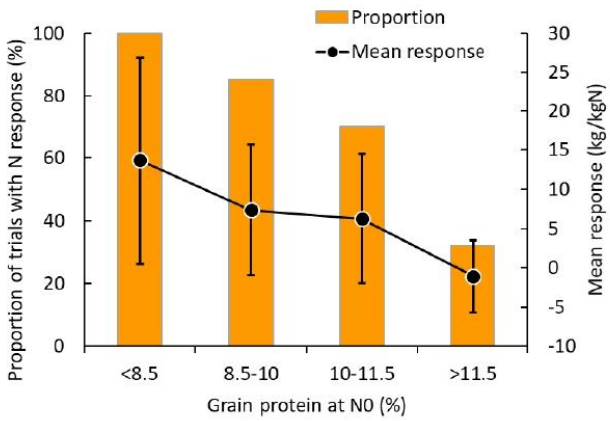
Protein thresholds: GPC as an indictor of adequate N





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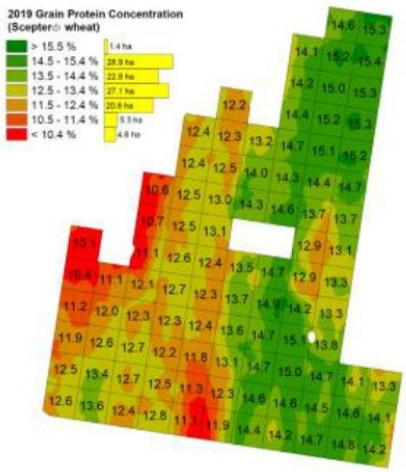
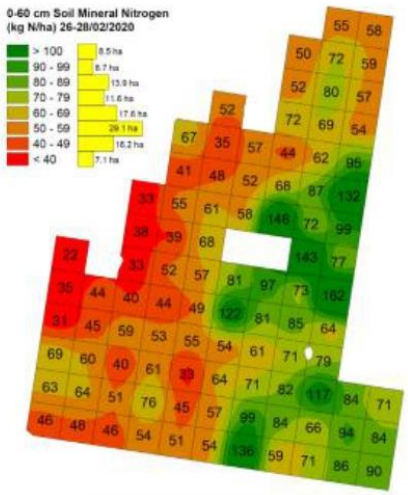
Does grain protein relate to residual soil N?

Grain protein 2019



Soil mineral N – Feb 2020



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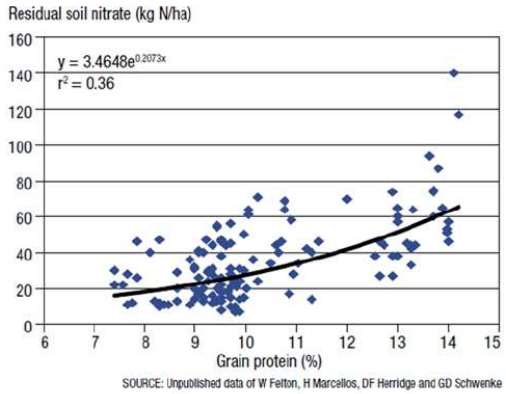
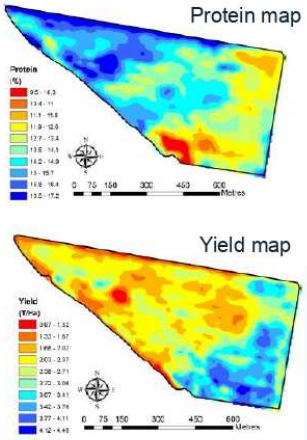
Issues to consider: spatial variability and protein dilution

Spatial variability



Downing (2013) GRDC Update

Protein dilution



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Summary

- N & S nutrition are strongly linked; grain analysis is a good check of S status and N-S balance
- There are different approaches to setting yield targets, but most are related to estimates of crop water supply; select a method you are confident with.
- Applying N during stem elongation up to flag leaf emergence can increase yields, but the response declines during this period .
- Benefits from late applications are more likely with high yielding crops with a high N requirement.
- Foliar N can be effective to increase grain protein – target late stem elongation to early grain fill.
- Grain protein can be an indicator of available N but protein maps need to be viewed with yield maps
- The 11% rule of thumb for grain protein is a useful guide but is not absolute

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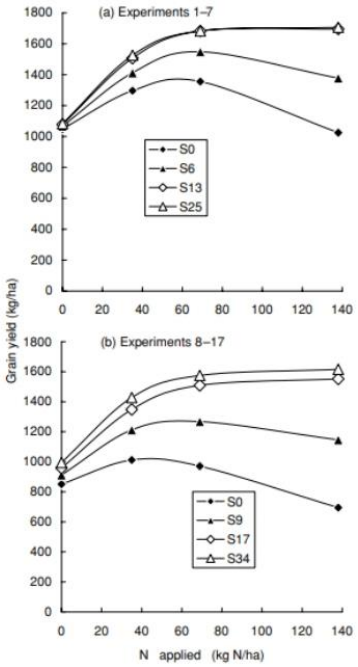
Extra notes



N and S interactions in wheat

Low S limits the responses to N

High N increases requirement for S and increases the risk of S deficiency

On situations where low S availability is a risk, N and S nutrition need to be managed together

Grain analyses: Mace - 2013 NVT

Site	Grain protein (%)	Sulphur (%)	N:S
Cummins	10.1	0.131	13.5
Keith	8.8	0.116	13.3
Minnipa	12.2	0.157	13.6
Nangari	10.4	0.138	13.2
Nunjikompita	11.5	0.142	14.2
Penong	10.9	0.138	13.9
Piednippie	9.7	0.129	13.2
Turretfield	13.4	0.162	14.5
Wanbi	13.5	0.166	14.3

S deficiency can be assessed using two criteria:

Grain S concentration <0.12%
N:S ratio > 16-17

Two sites show low grain S, indicative of S deficiency, although the N:S ratio is <16 because protein was low. This suggests N supply may be inadequate also.

Increasing N rate in subsequent years to improve crop N status may worsen the low S.

In situations where low S is a risk, grain analysis can provide information on the S status of the crop

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Grain survey - wheat

Region	No samples	Grain S (%)
Upper EP	12	0.178
Lower EP	5	0.149
Mid North	7	0.180
Murray Mallee	9	0.179
South East	5	0.178
Yorke Peninsula	6	0.165

Critical value – 0.12%

Norton (2012)

Grain analysis from NVT trial sites did not identify S deficiency in trials.

Mean values were lowest in among the Lower EP sites.

These values were from 10 years ago; there is little to no recent data to see if there has been any marked changes

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Grain survey – canola NVT sites

Region	Grain N (%)	Grain S (%)	N:S
Upper EP	3.69	0.313	11.8
Lower EP	4.09	0.325	12.6
Mid North	4.96	0.410	12.1
South East	4.52	0.392	11.5
Yorke Peninsula	4.57	0.373	12.3
LSD (5%)	0.24	0.037	

Critical value - 0.36%

Norton (2014)

Grain N (protein) and S concentrations on EP were lower than in other regions in the State

Low S may reduce the ability to response to N

Growers on EP may need to pay more attention to S than growers in other regions

There is only one published value for critical grain S forAustralian conditions

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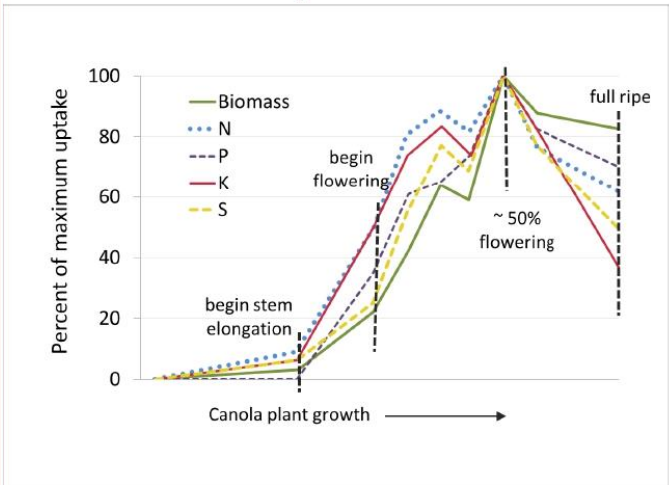
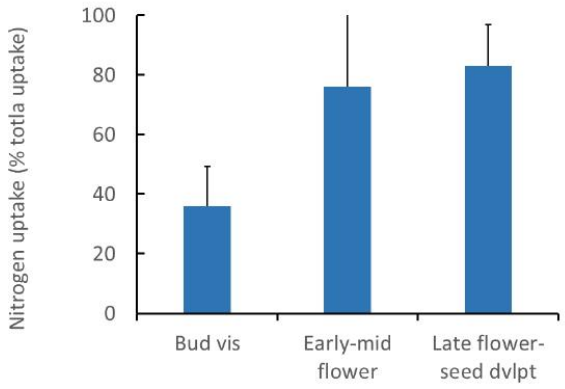
Nutrient uptake: Canola





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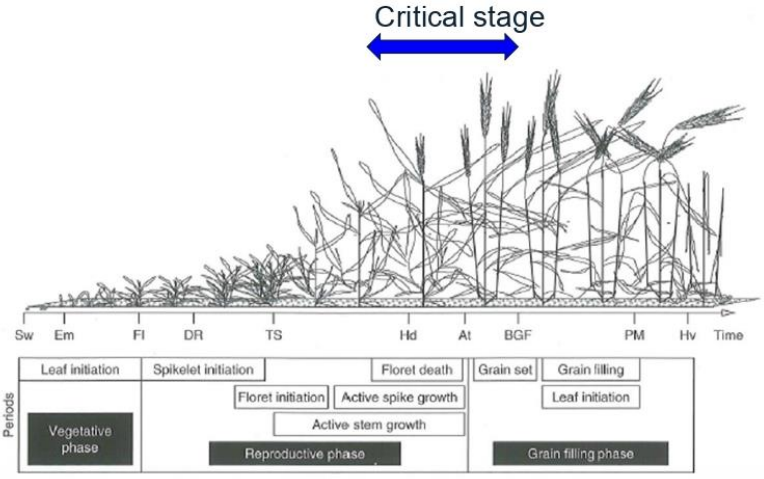
The critical stage of growth for yield



Em – emergence; Hd – heading; At- flowering; BGF – beginning of grain fill

Yield potential

- Sensitive to crop growth rate from ~Flag leaf emergence to ~1 week after flowering
- Stress at this time can have a large effect on yield compared to other periods of growth

N management

- Aim to make N a non-limiting factor at this stage

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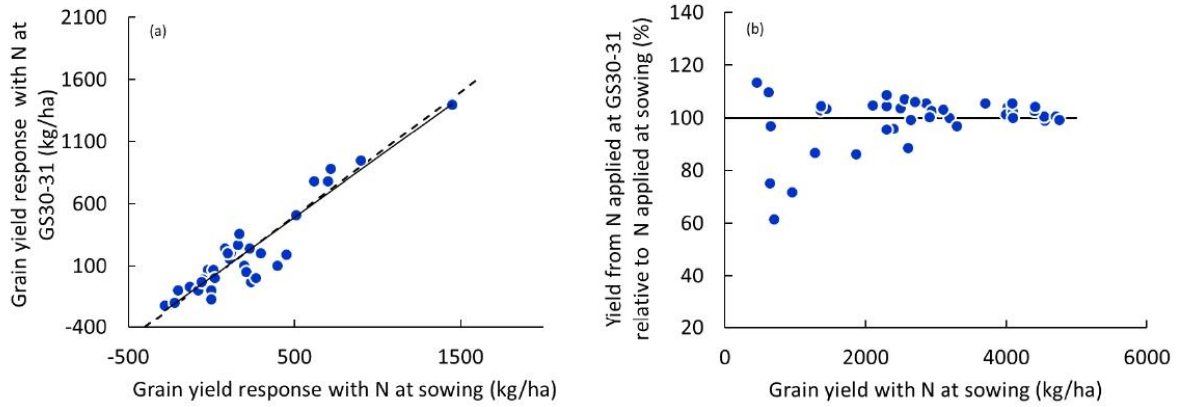
The benefit of delayed N is influenced by yield level



Similar yields are achieved when the N is applied at sowing and at the start of stem elongation.
Variation in response to delated sowing is high at yield levels <2-2.5 t/ha
At low yield sites there may be little benefit and higher risk from delayed application of N

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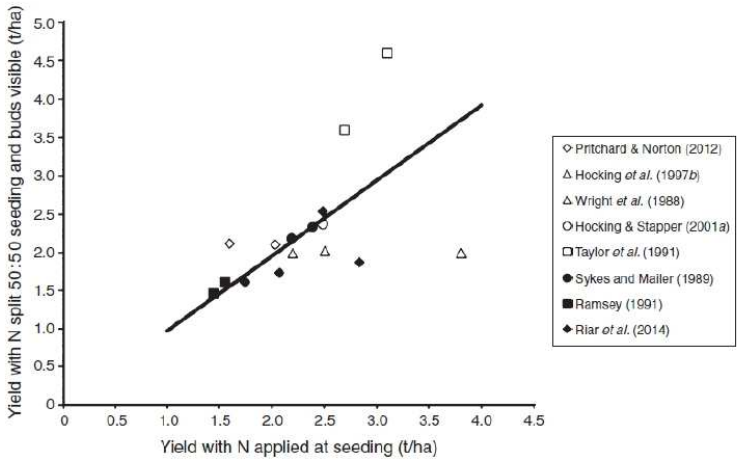
N in canola: rate is more important than timing



- Canola can recover from early N stress up to bud visible stage
- Spitting N between sowing and bud visible produce similar yields
- Delayed application may improve N efficiency when risk of losses are high (eg, high rainfall, high N rates)

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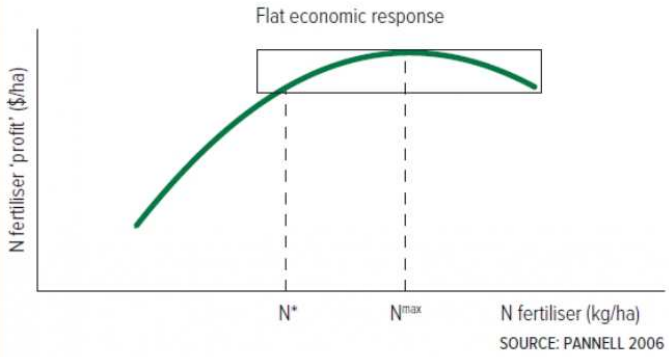
Do we need to get it exactly right?



- The profit response curve describes the effect of N rate on the profit from applying N
- The response curve is relatively flat around the optimum rate
- There is a range of N rates that are within 90% of the maximum economic rate
- This widens the margin for error in decision making

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Easy Precision Agriculture: Beth Humphris

Air EP

Easy Precision Agriculture

Mapping and how it can be used for nutrient management

Nitrogen

High Yield, High Protein	High Yield, Low Protein	Low Yield, High Protein	Low Yield, Low Protein
Maintain soil health and fertility	Consider more N	Possibly other constraints at play	Consider applying more N
• Approx. same N rate year on year	• Consider grain pricing and if this is advantages	• Soil constraints • Investigate if these can be fixed • Poor spring rainfall	• Look for other yield constraints first

-Identify production zones

-Assign yield potential to each zone

-Calculate total N requirement

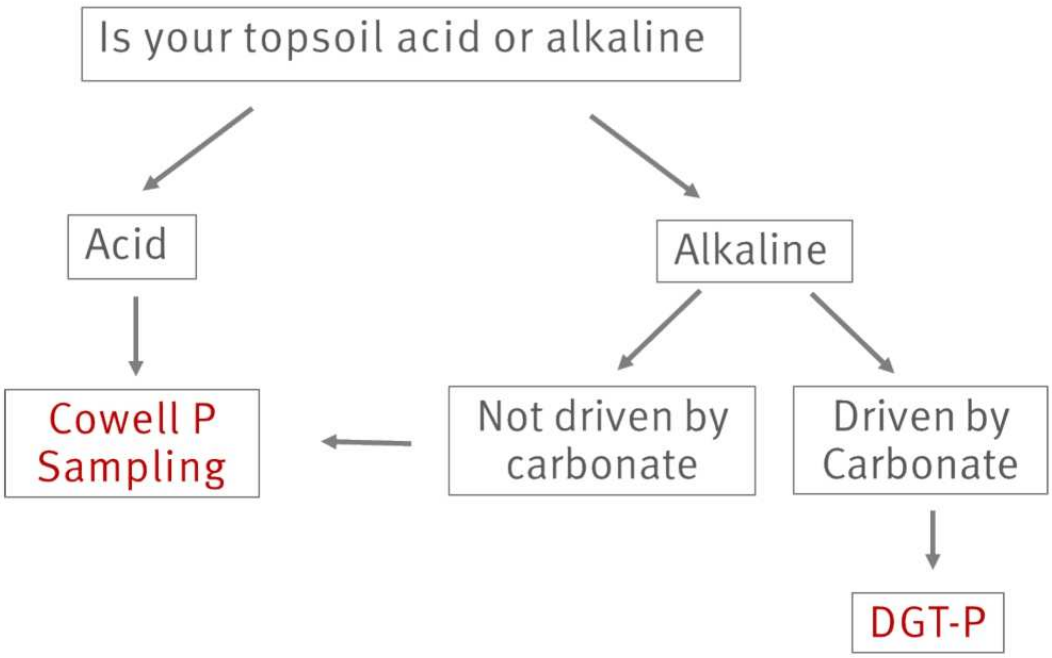
-Soil sample to identify N bank

-Calculate the difference and find urea requirement

Beth Humphris pH: 0418327460 Email: beth.humphris@elders.com.au

Mapping and how it can be used for nutrient management

Phosphorous



-Choose soil test type

-Baseline phosphorous levels and decide if you need capital P or just replacement

-Calculate fertilizer rates and make maps

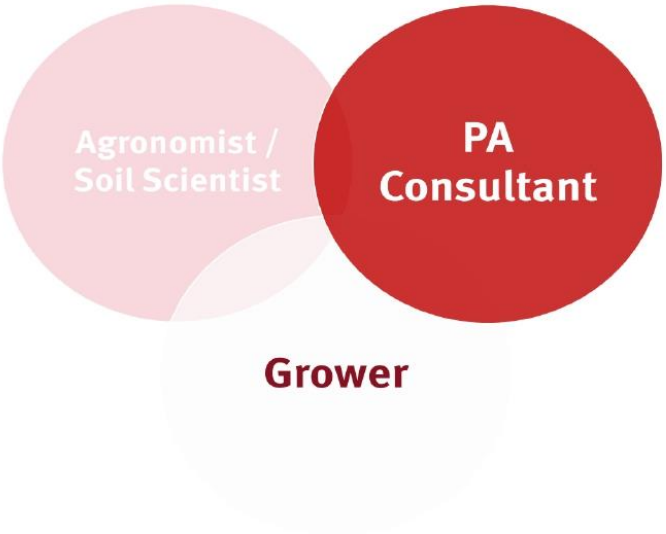
Cowell P (mg/kg)	Rating	Strategy
<15	Very low	Capital P + Maintenance P
15 – 29	Low	Capital P + Maintenance P
30 – 45	Optimum	Maintenance P
46 – 70	High	Reduced maintenance P
> 70	Very High	Starter P only (5 – 6 kg P/ha)

DGT-P	% Max yield (wheat)	Strategy
16	60%	Capital P + Maintenance P
41	80	Capital P + Maintenance P
52	90	Maintenance P
70	95	Reduced maintenance P

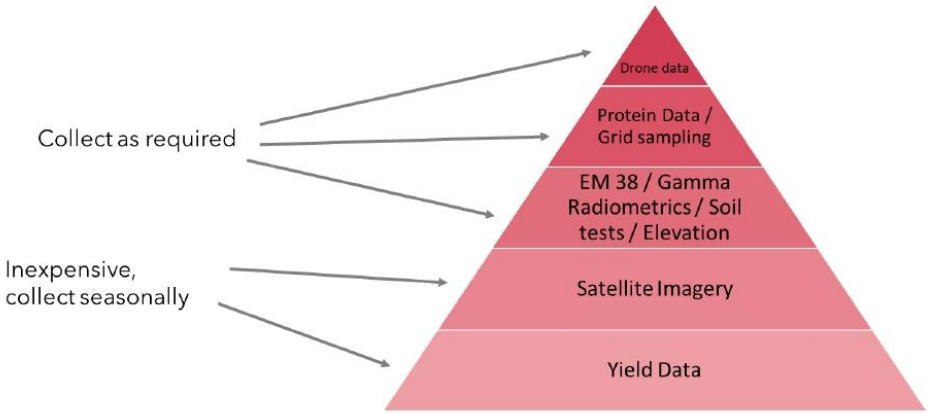
Beth Humphris pH: 0418327460 Email: beth.humphris@elders.com.au

Easy things you can adopt and the best places to start

Get the right people in your corner!



Gather current available layers and ensure the layers you invest in tell you something important



Be strategic!

-Consider where you are in the rotation

-Look at variability %

-Seek low hanging fruit first

-Sample strategically and with a whole of farm approach