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Soil Amelioration Research

AAAC Meeting, 11 April 2019

1. Soil Wetters
2. Soil Compaction
3. Soil Acidity
4. Deep Soil Mixing and Inversion
5. Amelioration Economics - ROSA
6. New Research Projects
7. Discussion

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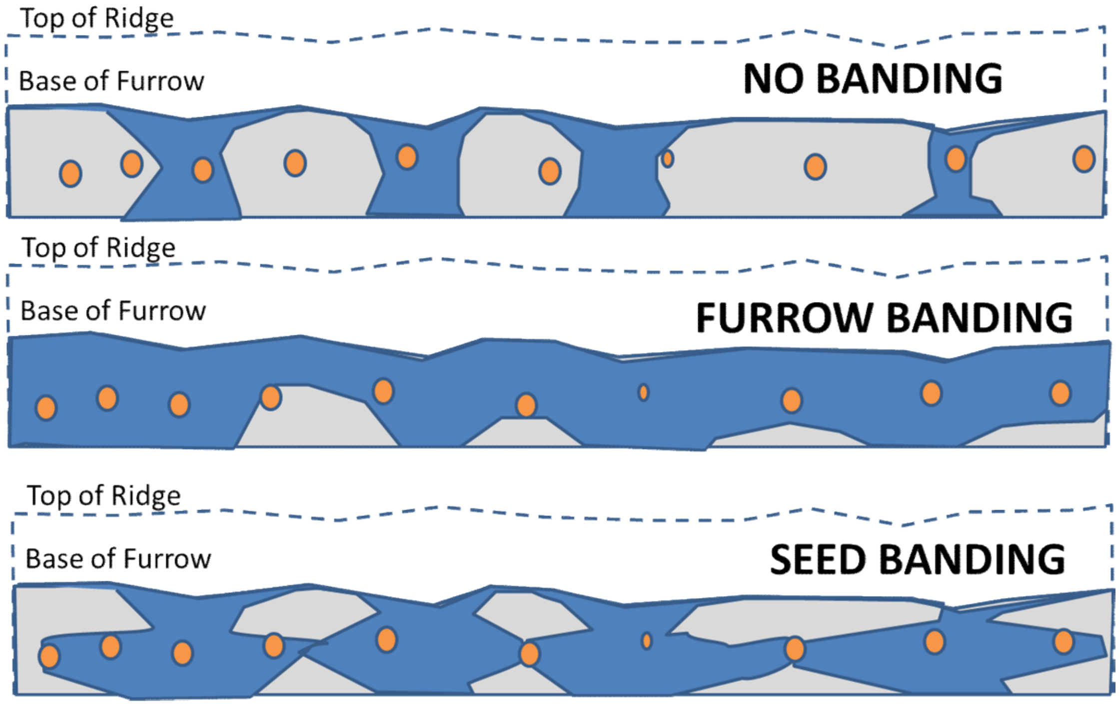
Banded wetters for repellent soils

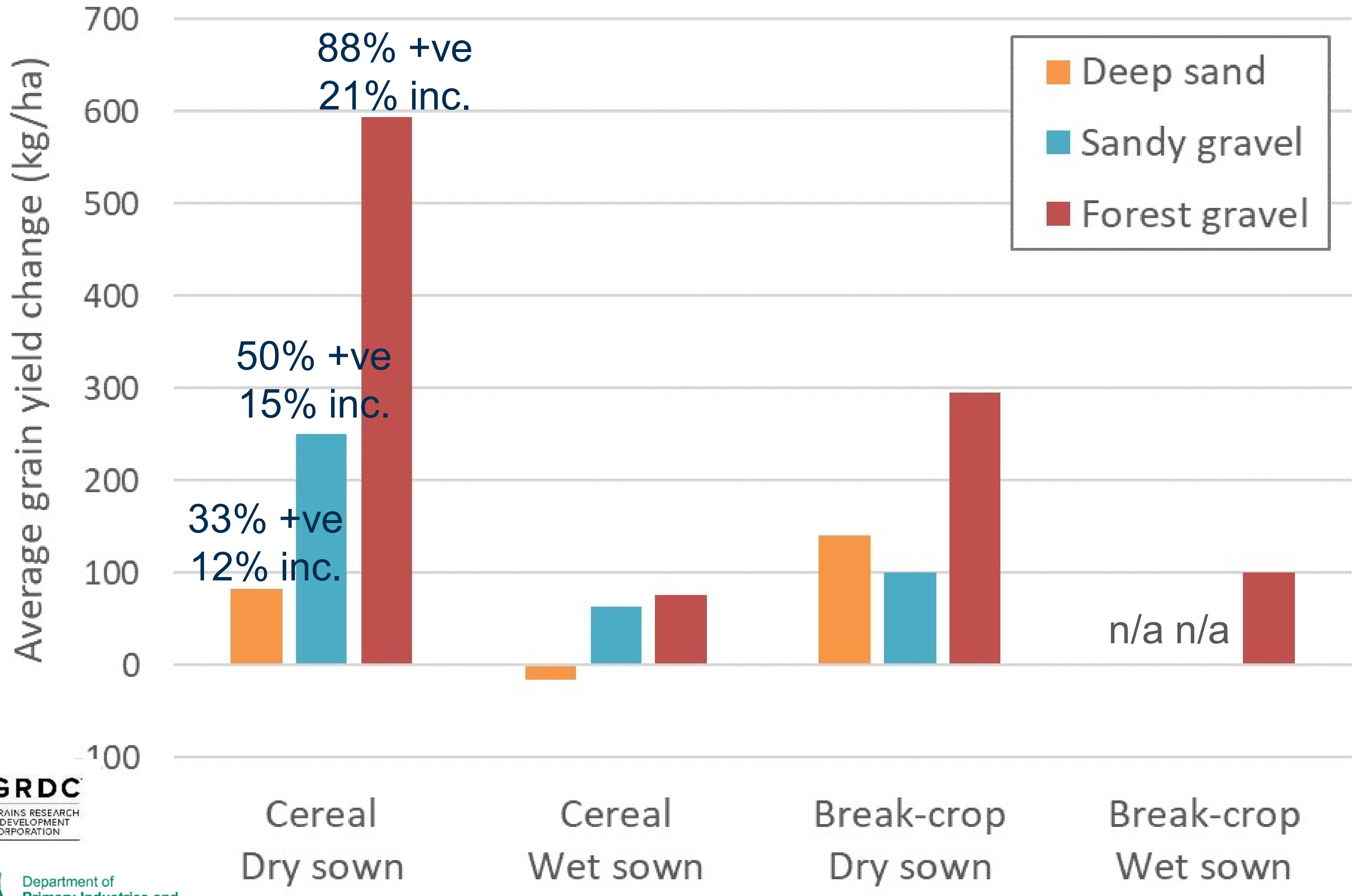
Steve Davies, Glenn McDonald & Geoff Anderson, DPIRD

Banded Wetters

- Annual application
- Cost $8-21/ha



Summary 10-years Banded Soil Wetter Research Trials



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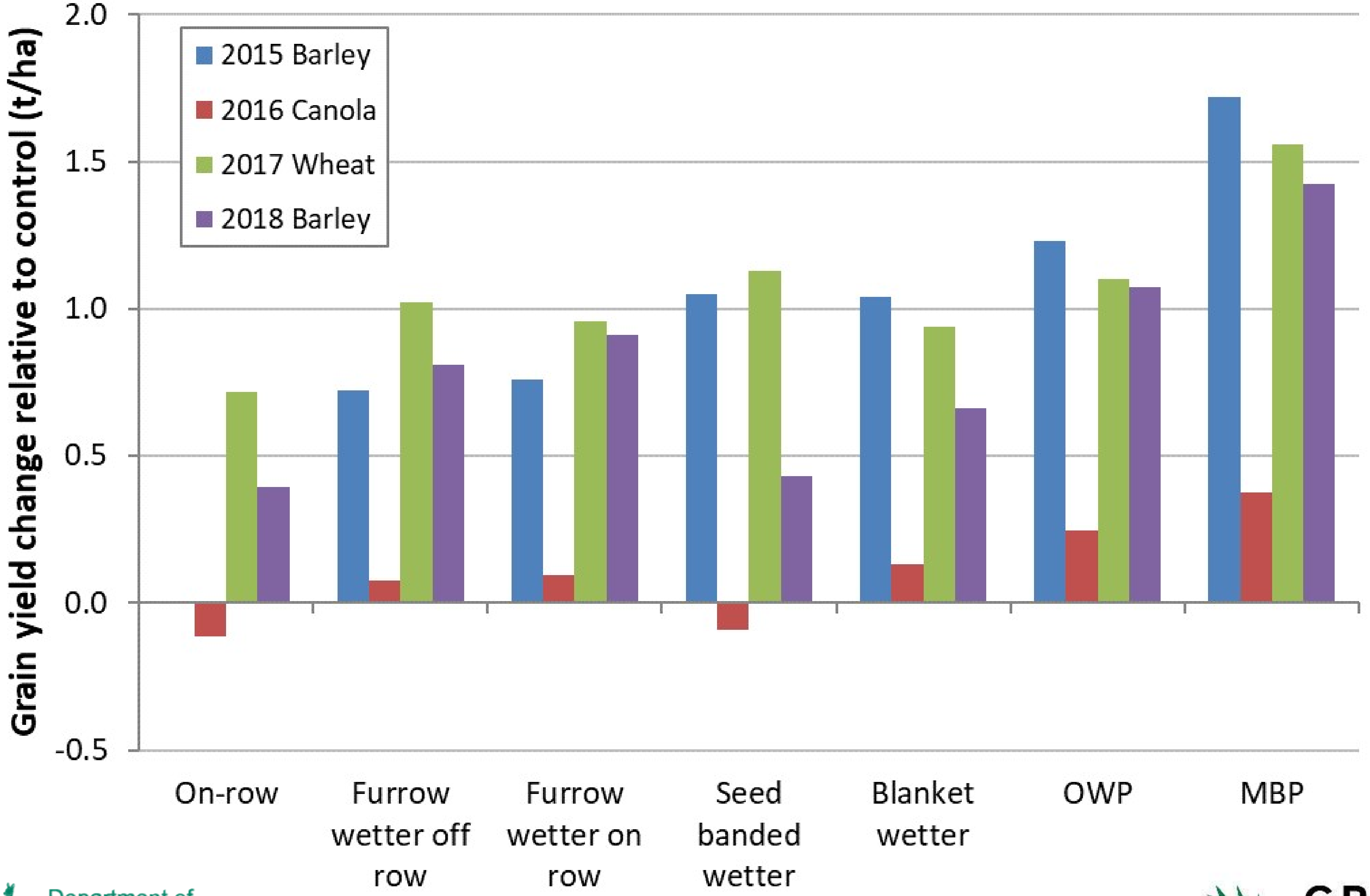
Comparing Systems on Forest Gravel



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Banded Wetter Summary

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1. Most responsive and reliable crop responses on forest gravel soils
2. Most benefit for cereals with marginal moisture at seeding
3. Variable responses on repellent sands – paired or near-row sowing more reliable establishment benefits
4. On responsive soils wetters are effective for either on furrow or near seed placement
5. On forest gravels fresh annual application of wetters residual value of is small
6. Higher rates and new products may improve outcomes but cost more so ROI could still be an issue

Acknowledgement: DAW00244 Soil Water Repellence

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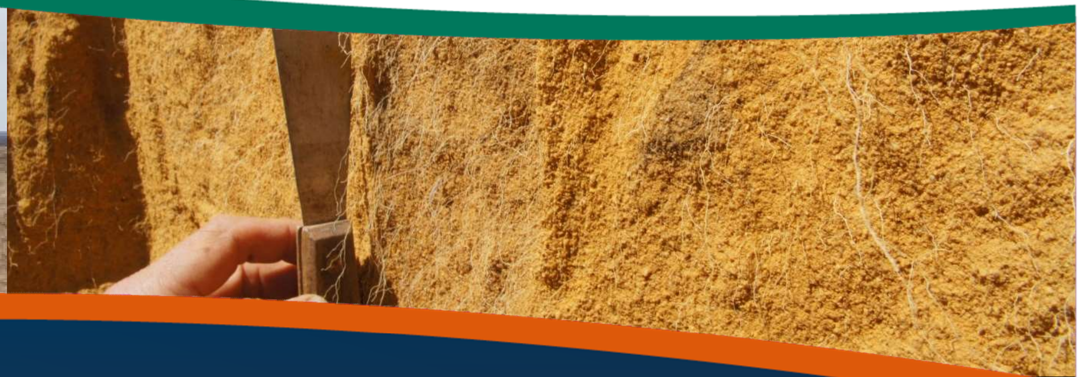
Minimising the impact of compaction on crop yield

DAW00243



Moora; Yield % of Nil

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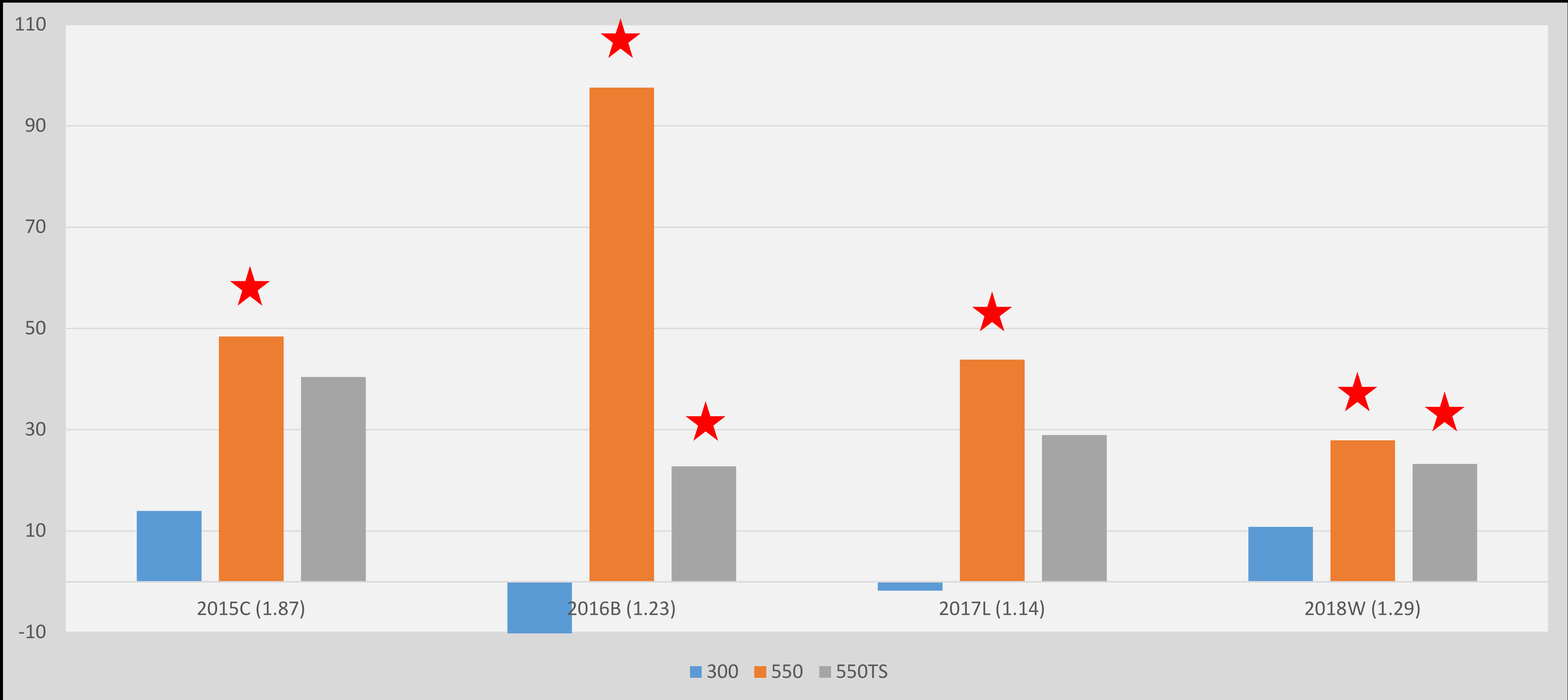

Moora Root Assessment

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Munglinup; Yield % of Nil

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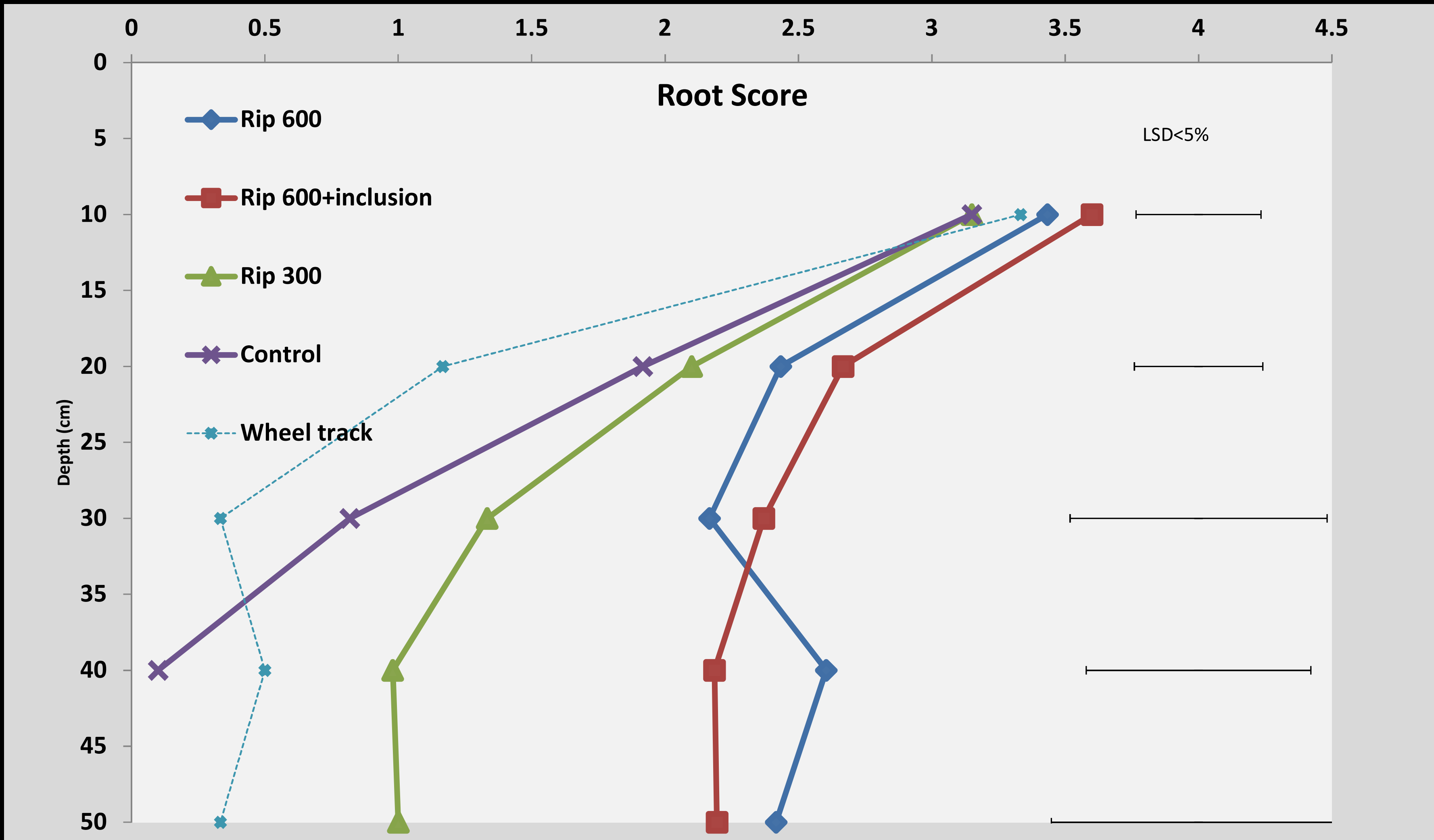
Results - Munglinup



0 – nil roots

5 – lots of roots

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Depth vs Breakout

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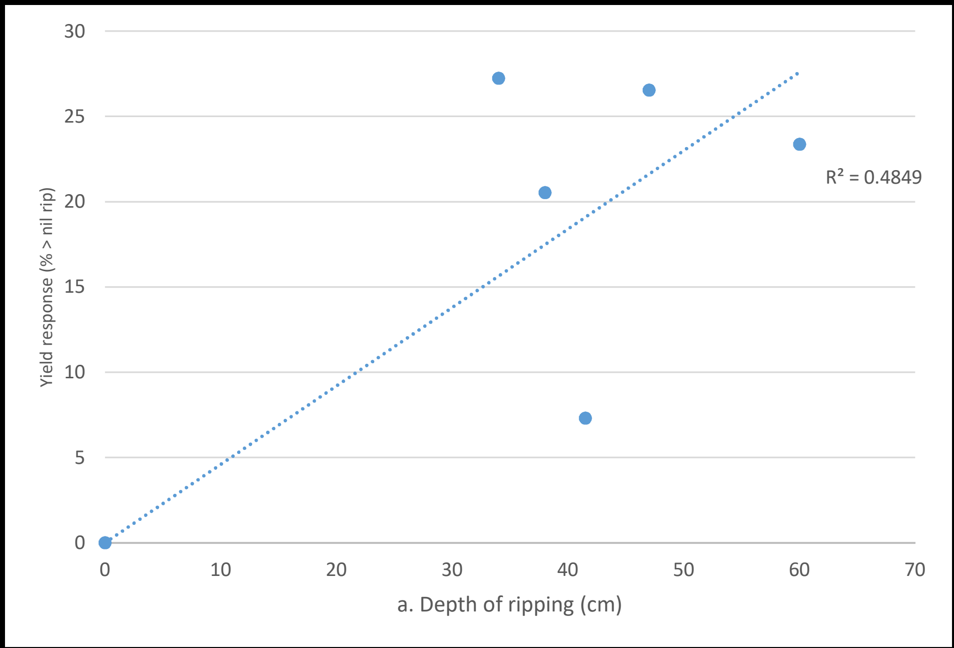

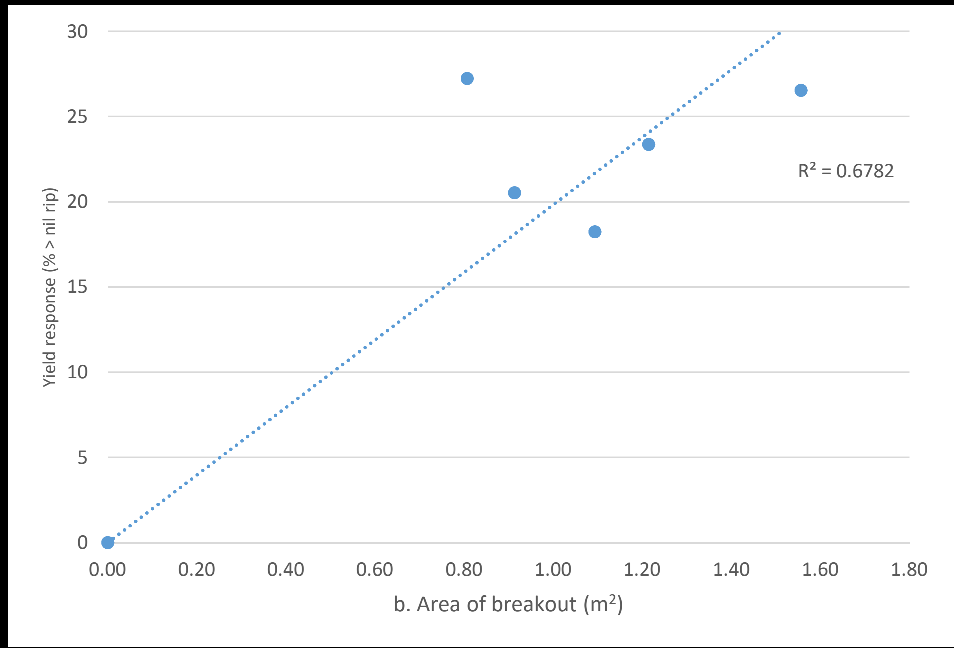

	Area breakout (m^2)	Total cost ($/ha)	Average Yield (t/ha)	Return ($/ha)	Ripping benefit ($/ha)	Cost/m^2:Return	Year 1 Return On Investment
Nil	0.00		3.02	882			
Terraland	0.91	66.4	3.64	997	115	0.63	0.73
Ausplow	1.09	27.6	3.57	1 015	133	0.19	**3.84**
Imants 58 Series	1.56	90.3	3.82	1 026	144	0.40	0.59
Hydramax	1.21	65.3	3.73	1 023	141	0.38	**1.16**

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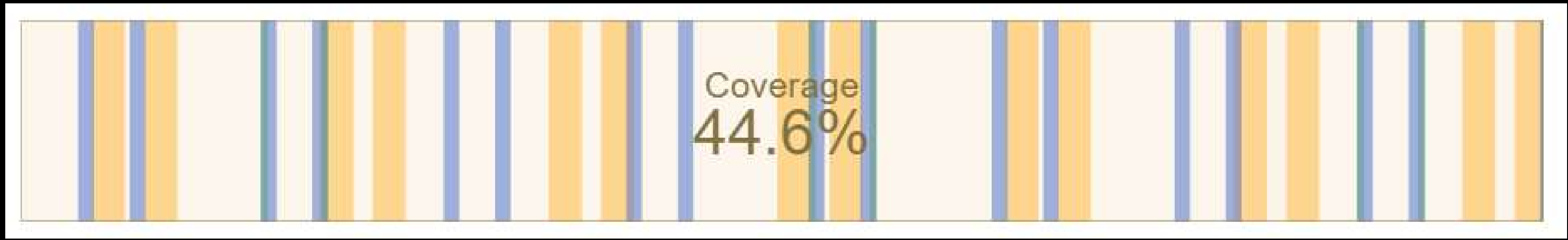
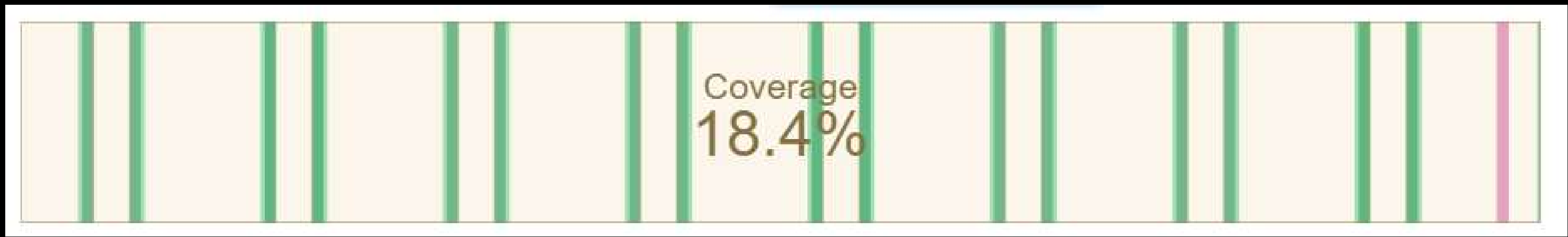


www.ctfcalculator.org



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Updates in soil acidity Research

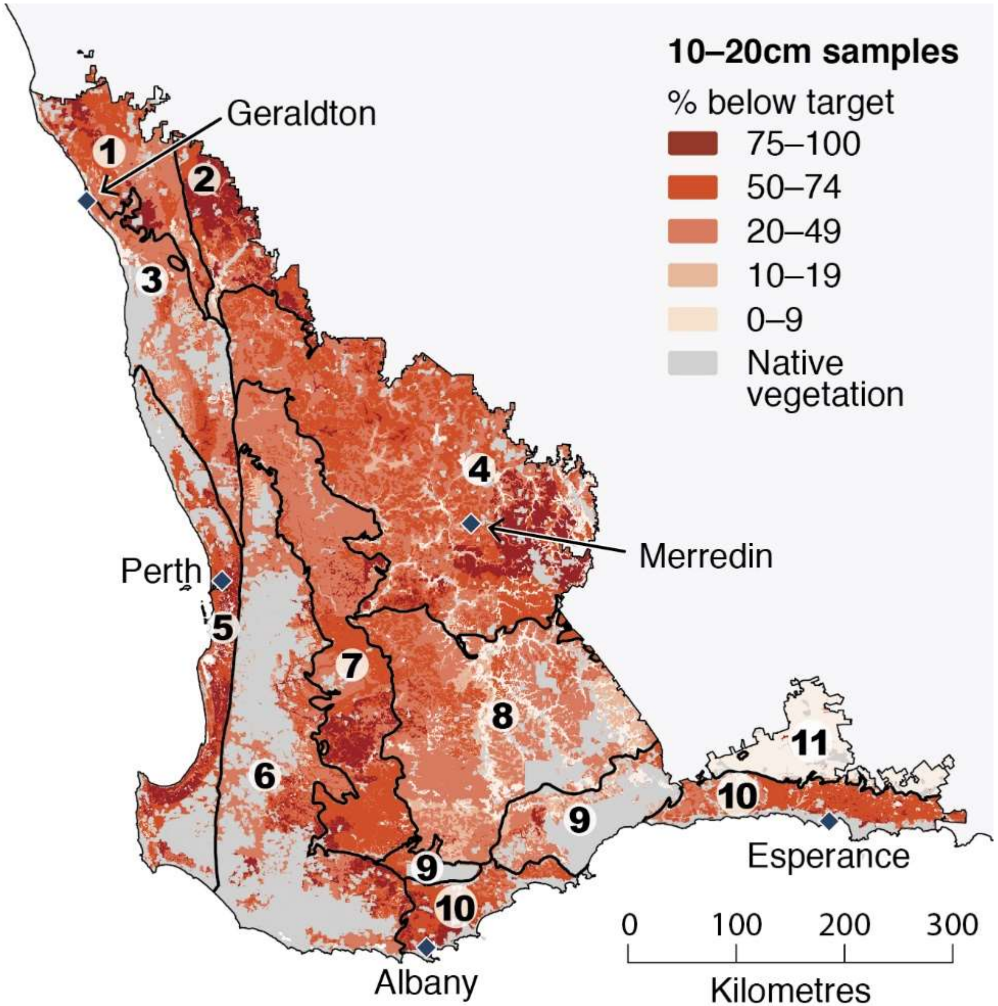
Dr Gaus Azam
Soil Scientist, CPSS
DPIRD

Progress in managing soil acidity in WA

Researchers, consultants & growers made good progress:

But subsurface soil is still a big issue:

- 50% of subsurface <pH$_{Ca}$ 4.8



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Target high: a small trial in Kalannie

- To clear up confusion (from some of us)
- A blue sky research (soil pH profile engineering)

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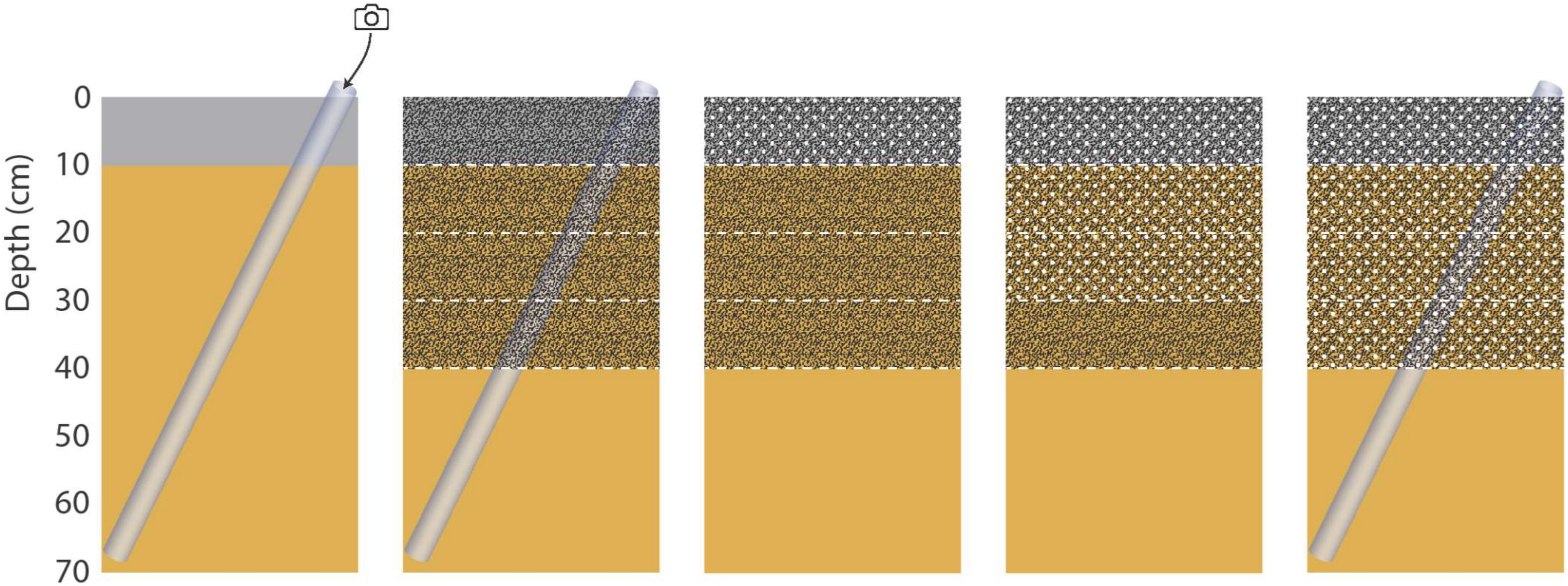
Experimental details



Control

Incorporation only

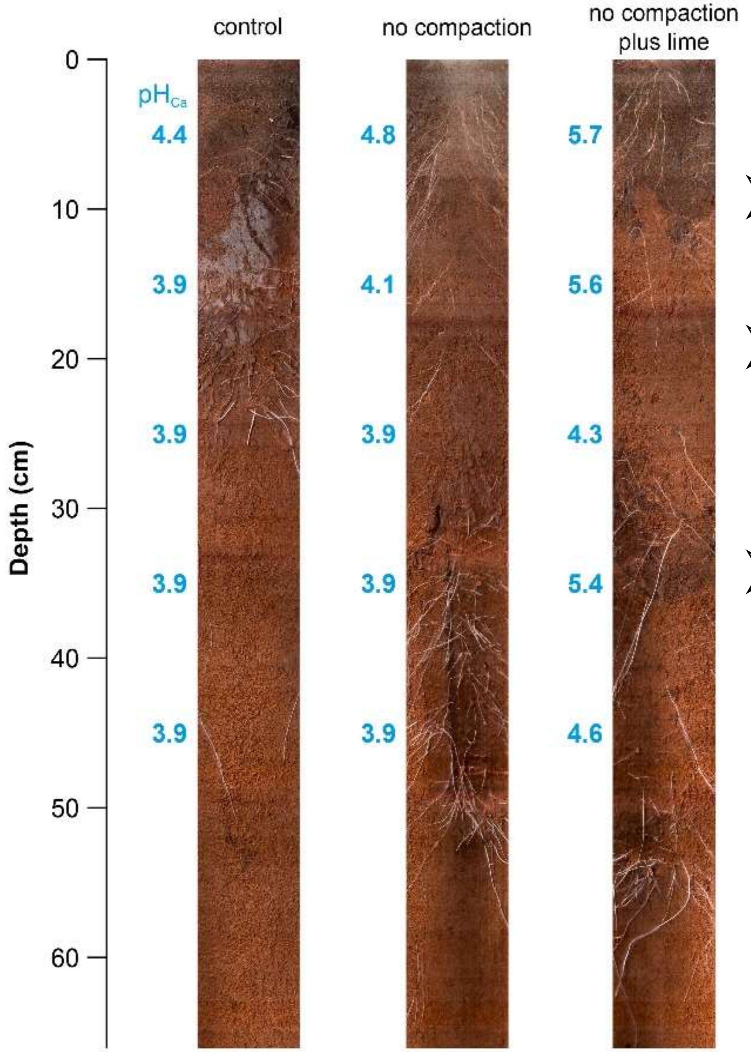
1.5 t/ha in top 10 cm + 10-45 cm incorporation only

4.5 t/ha in top 30 cm + 30-45 cm incorporation only

6.0 t/ha incorporated in 0-45 cm

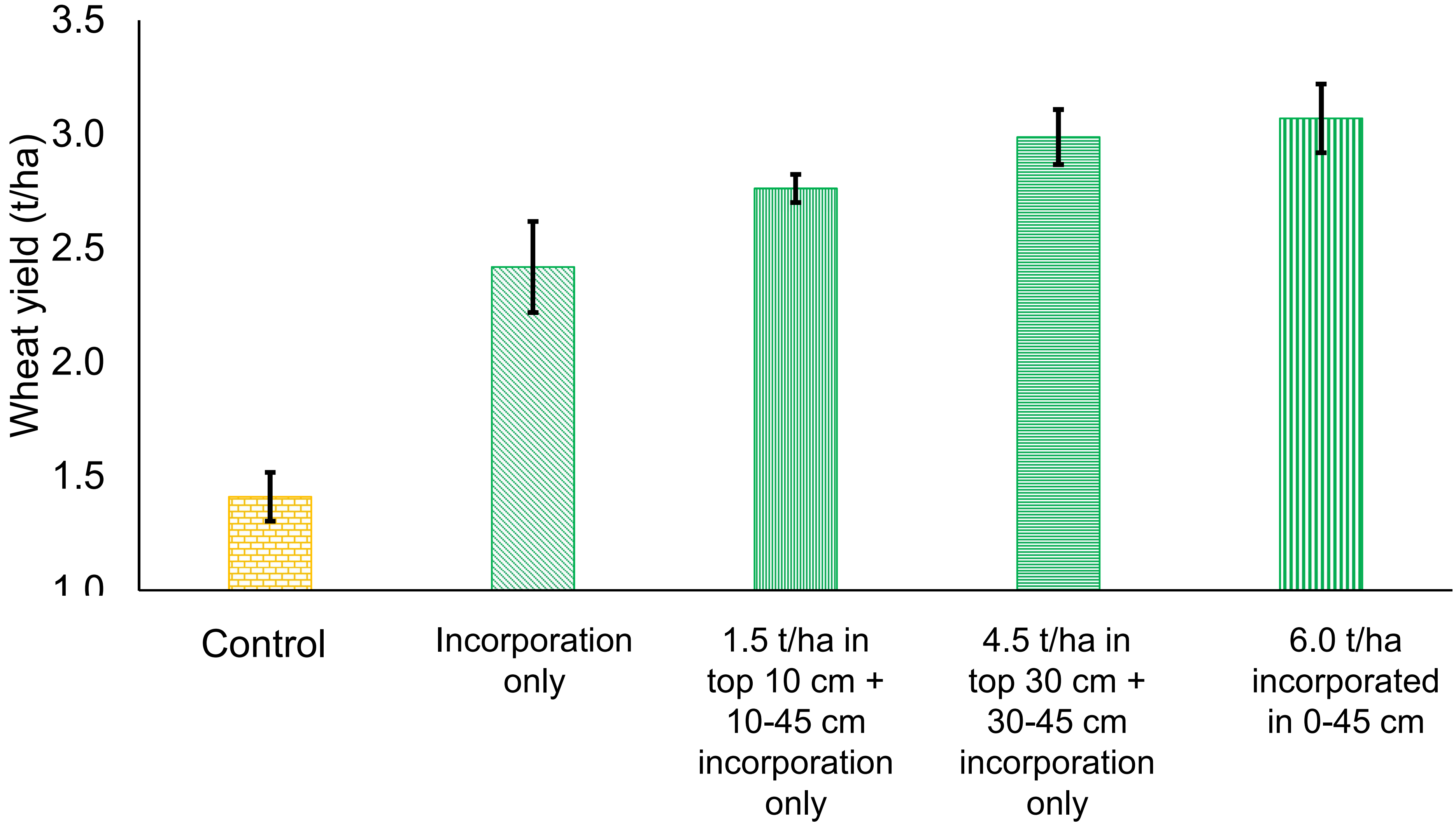
Above and below ground growth of wheat

360 degree camera

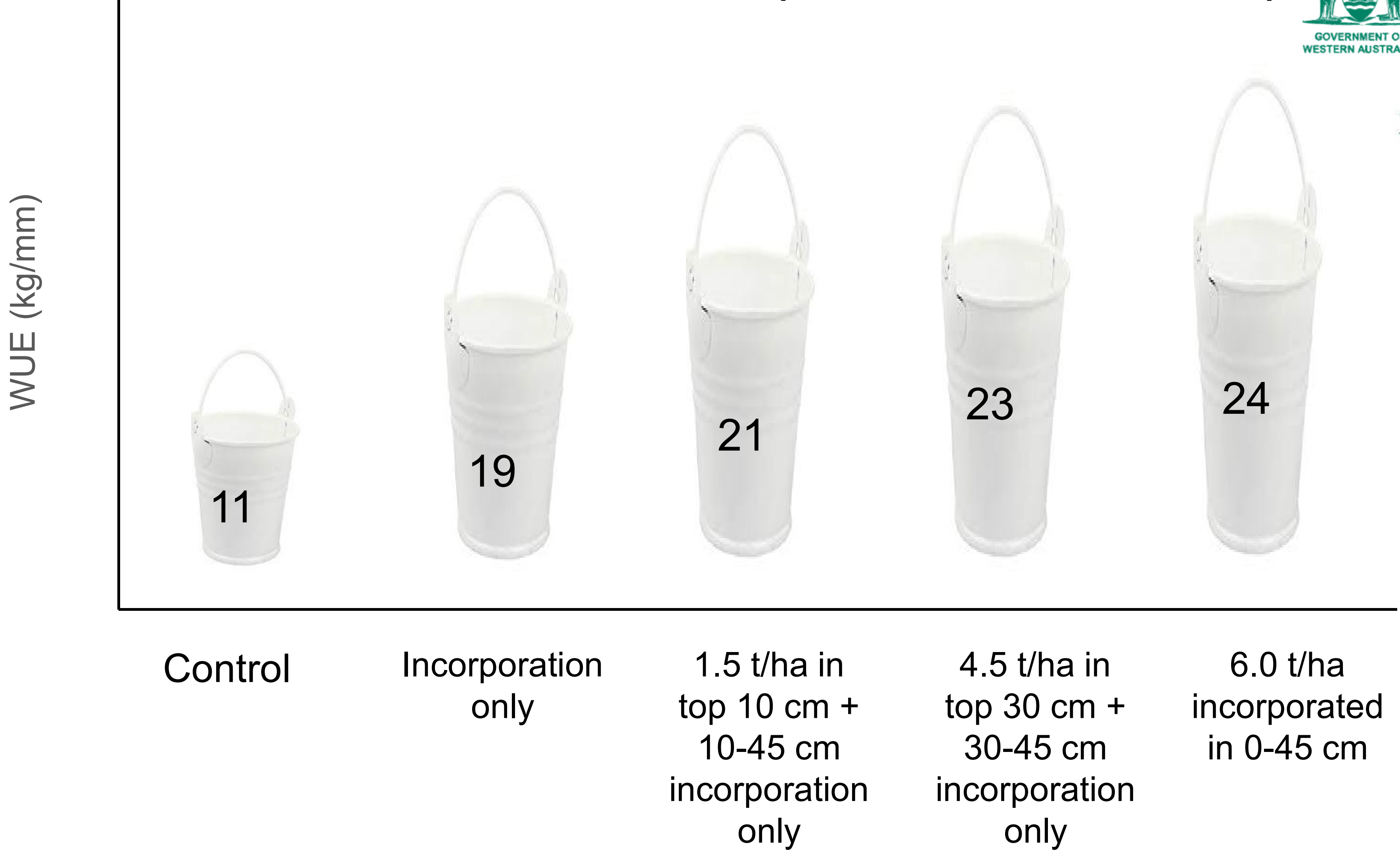


- Control = ~20 cm
- Incorporation only = ~60 cm
- Deep lime incorporation = ~65 cm + fine roots

Yield in 2018 (175 mm rainfall)



WUE in 2018 (175 mm rainfall)



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The good old solution

Lime, re-lime, re-lime

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Yield response in 2018

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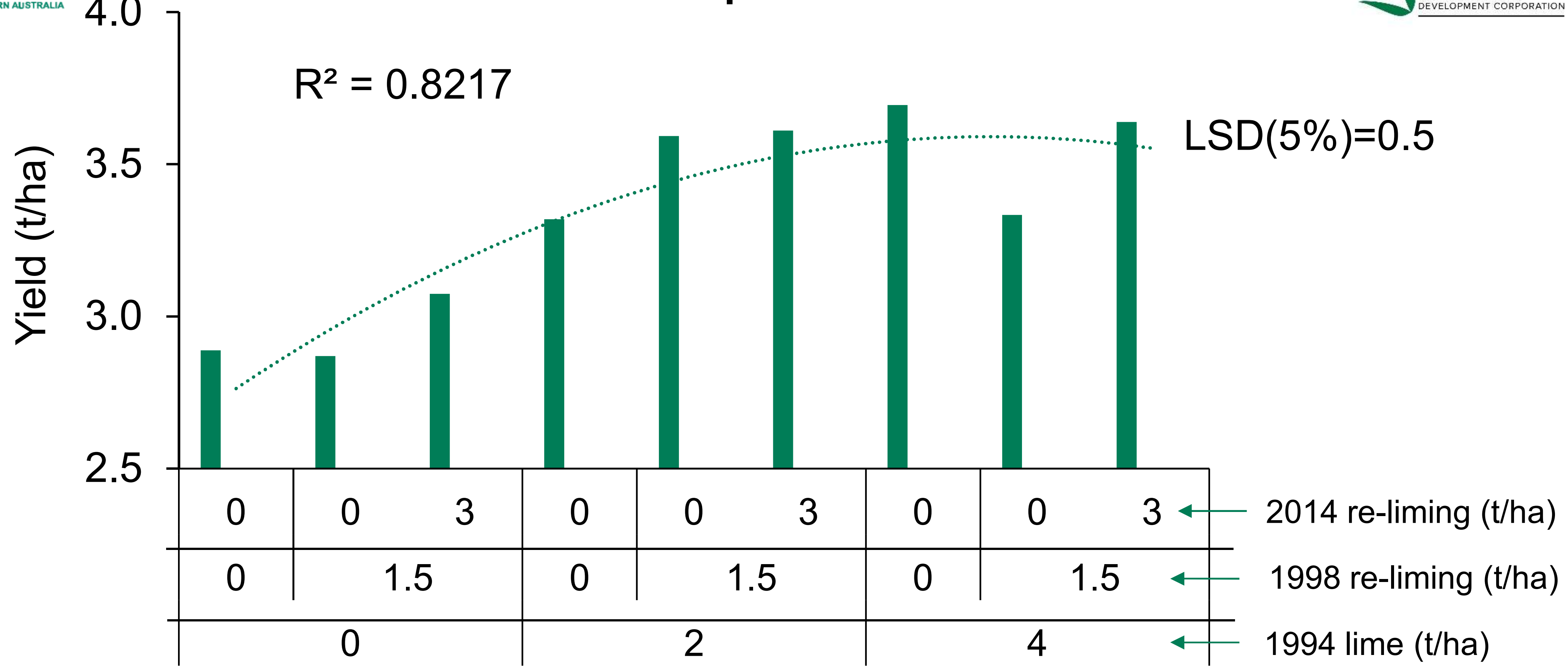
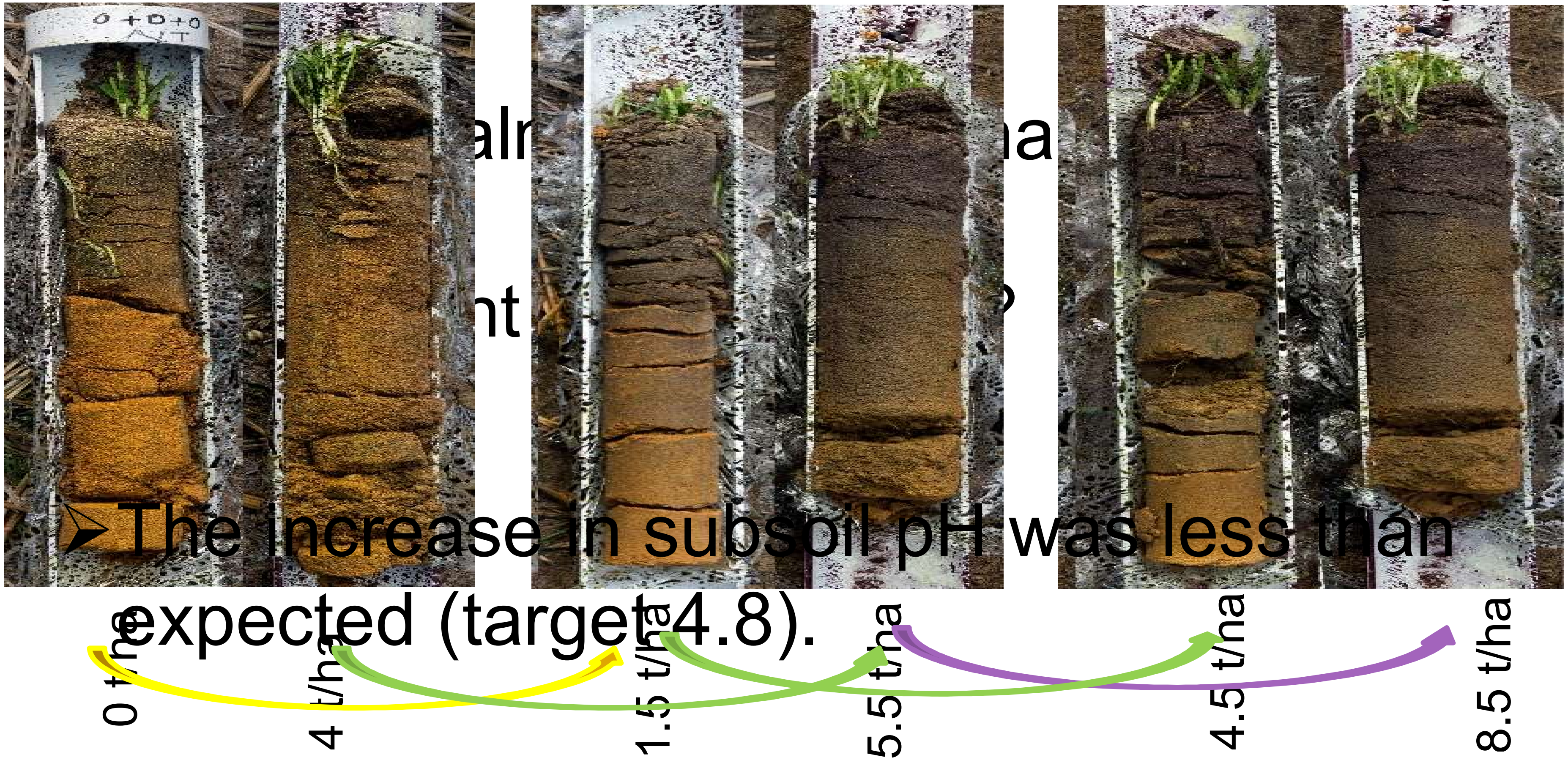


- After 23 years, up to 0.75 t/ha of wheat from surface liming

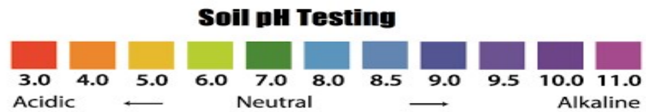
Soil pH profile (2018)

-- liming strategies --

1994 liming | 1998 re-liming | 2014 re-liming



- ➢The increase in subsoil pH was less than expected (target 4.8).
- ➢Where did the lime go?



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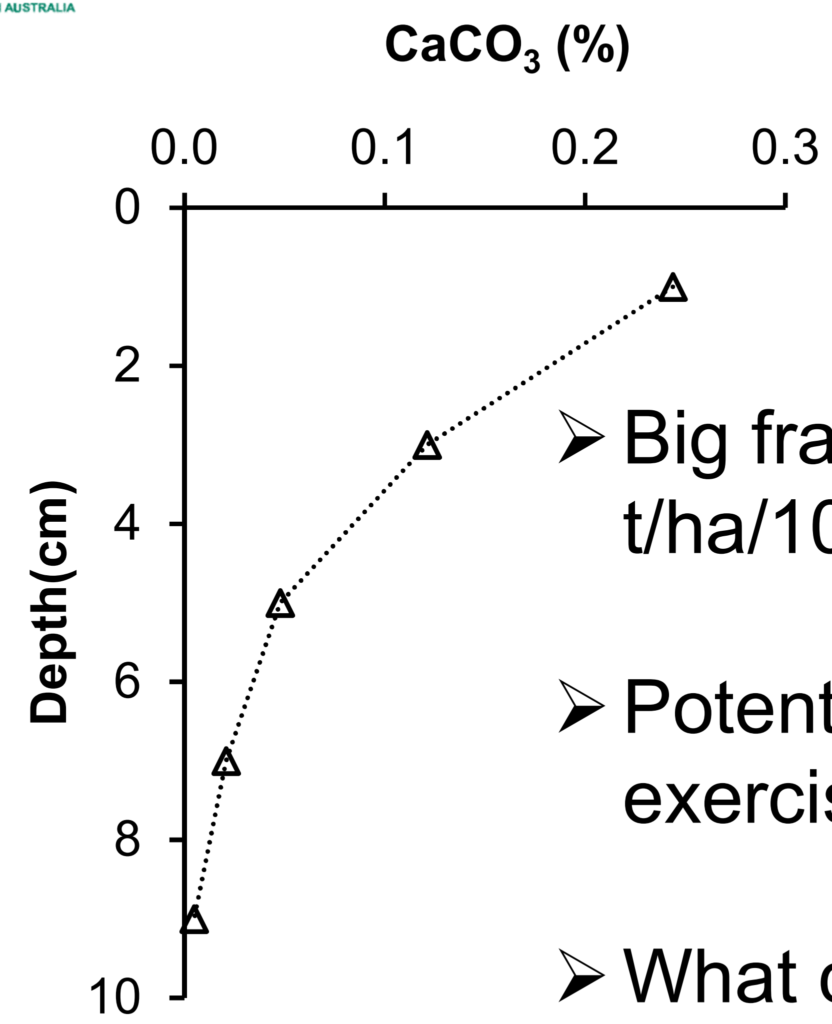
Missing piece of puzzle

- Where did the lime go?

Undissolved lime and potential use



- Big fraction stratified (0.2% = 2.5-3.0 t/ha/10cm)
- Potential to fix up to 0.8 m depth (lab exercise)
- What can we do in the paddock?

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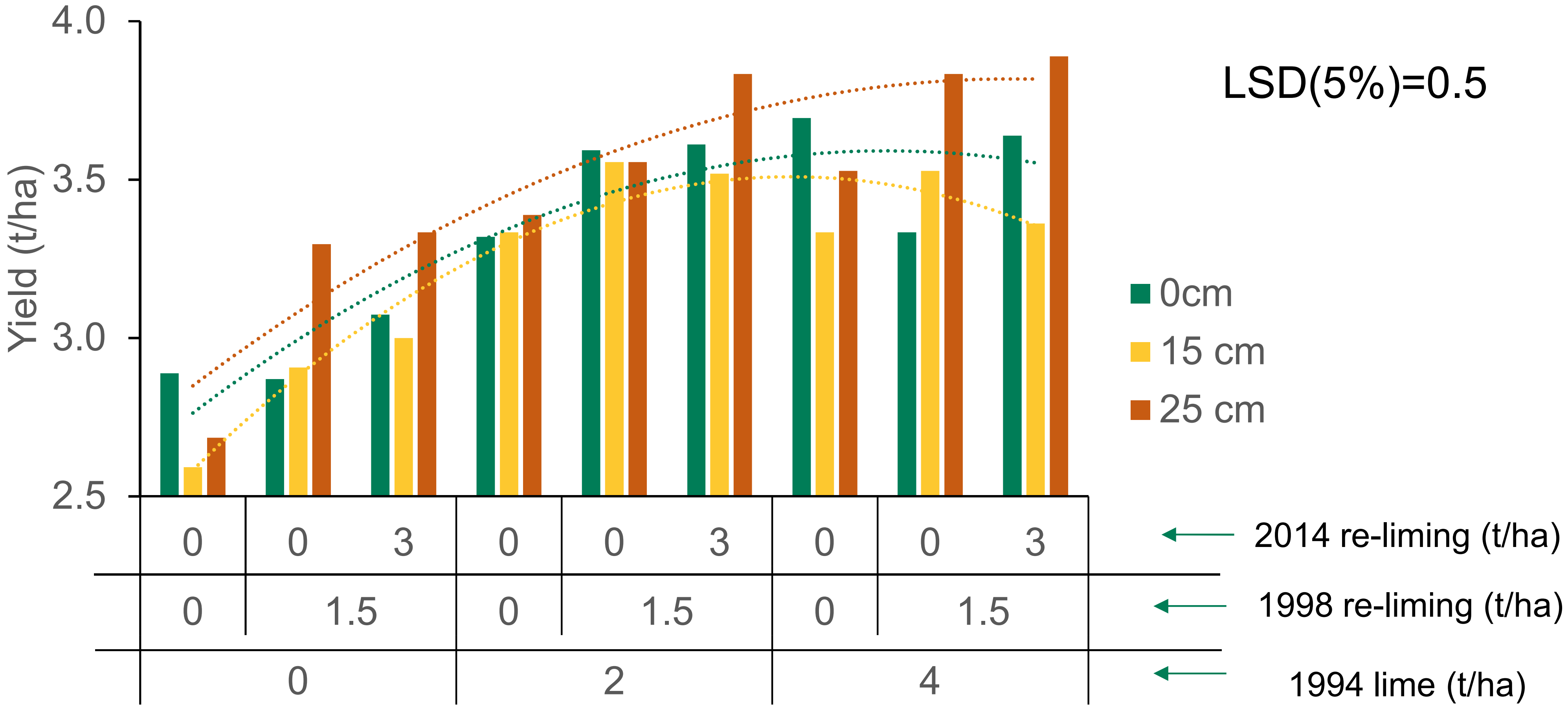
Just re-incorporation of residual lime



Just re-incorporation of residual lime

- 25cm deep incorporation added 0.25 t/ha extra yield
- What if we incorporate >25cm?

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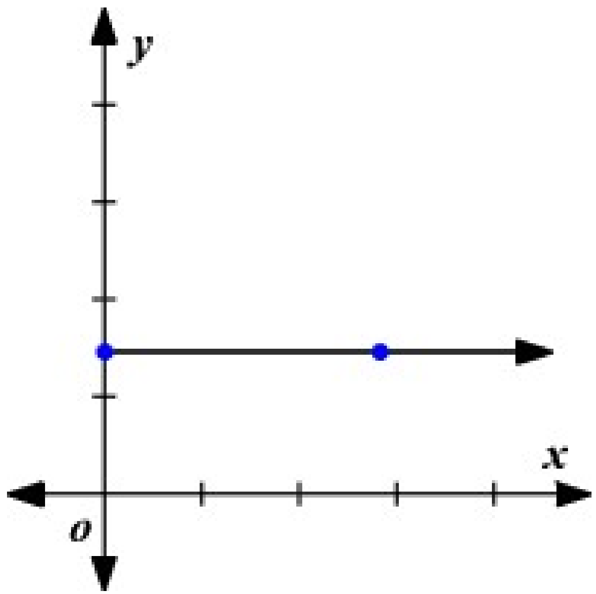
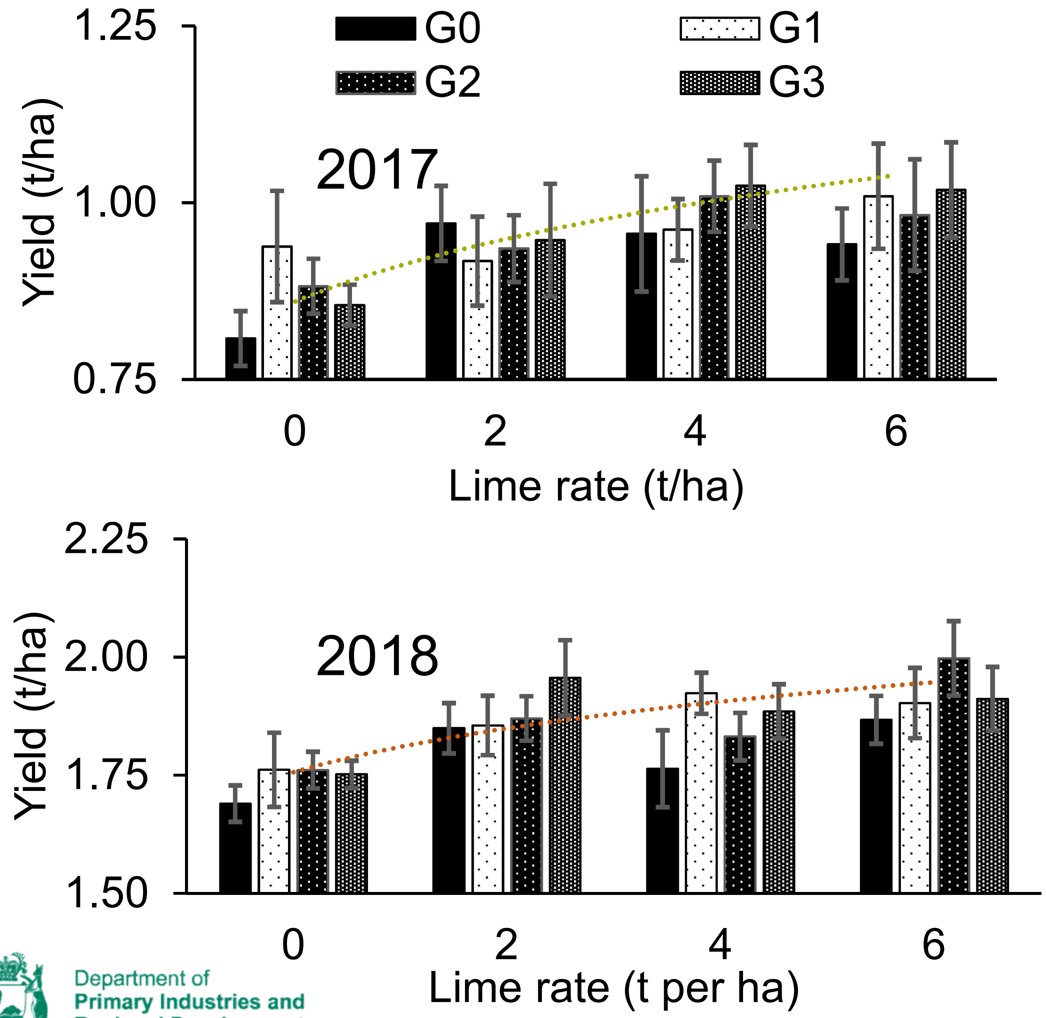
Added value to old solution



- Can gypsum enhance the results we get from liming?

Lime-Gypsum Interaction and grain yield



- Lime: 12-13%
- Gypsum: 5-11%
- Combined: 23-30%

What is the mechanism?

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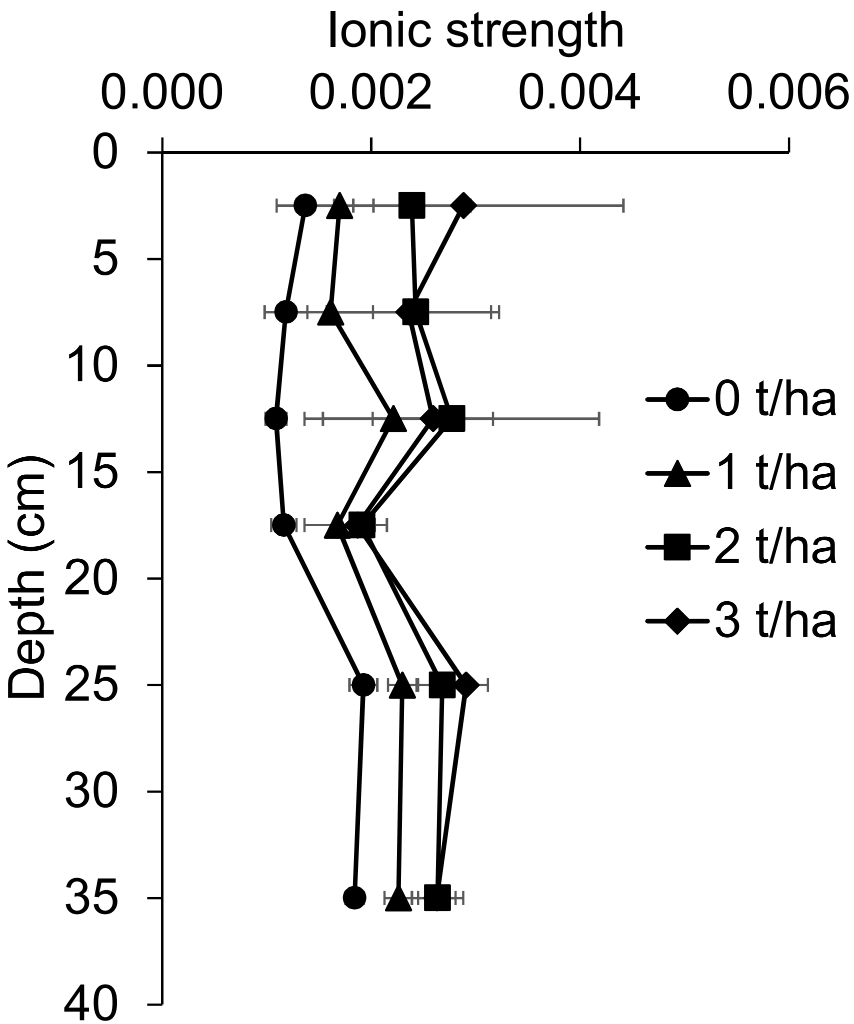
Lime-Gypsum Interactions: improvement in soil chemistry



- **Lime:** Increased soil pH and hence a decreased in Al toxicity
- **Gypsum:** Increased the ionic strength (reduced the relative activity of Al)

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Take home messages

1. Recurrent liming to mange the whole profile
   - improved subsoil acidity and crop yield, BUT
   - lime stratified in top few centimetre soils,
   - deep ploughing to re-incorporate can rapidly increase subsoil pH and add extra yield.

2. Lime and gypsum combining strategy
   - Up to 30% yield improvement with combined application
   - Lime helped increasing pH, decreasing Al and increasing macro-nutrient uptake
   - Gypsum helped increasing ionic strength (reducing relative Al activity), provided S and increased micro-nutrient uptake

3. Deep incorporation of completely acidic soil profile has potential to double the grain yield and WUE.

Acknowledgements

Supporting and partner organisations

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THE UNIVERSITY OF WESTERN AUSTRALIA

Government of South Australia
Primary Industries and Regions SA

A group of great people

- Nixon Family
- Giacomo Betti, Jen Clausen, Paul Damon, Shahab Pathan
- Daron Malinowski & Gavin Sarre
- Shari Dougall & Bruce Thorpe
- James Fisher, Dr Jason Condon

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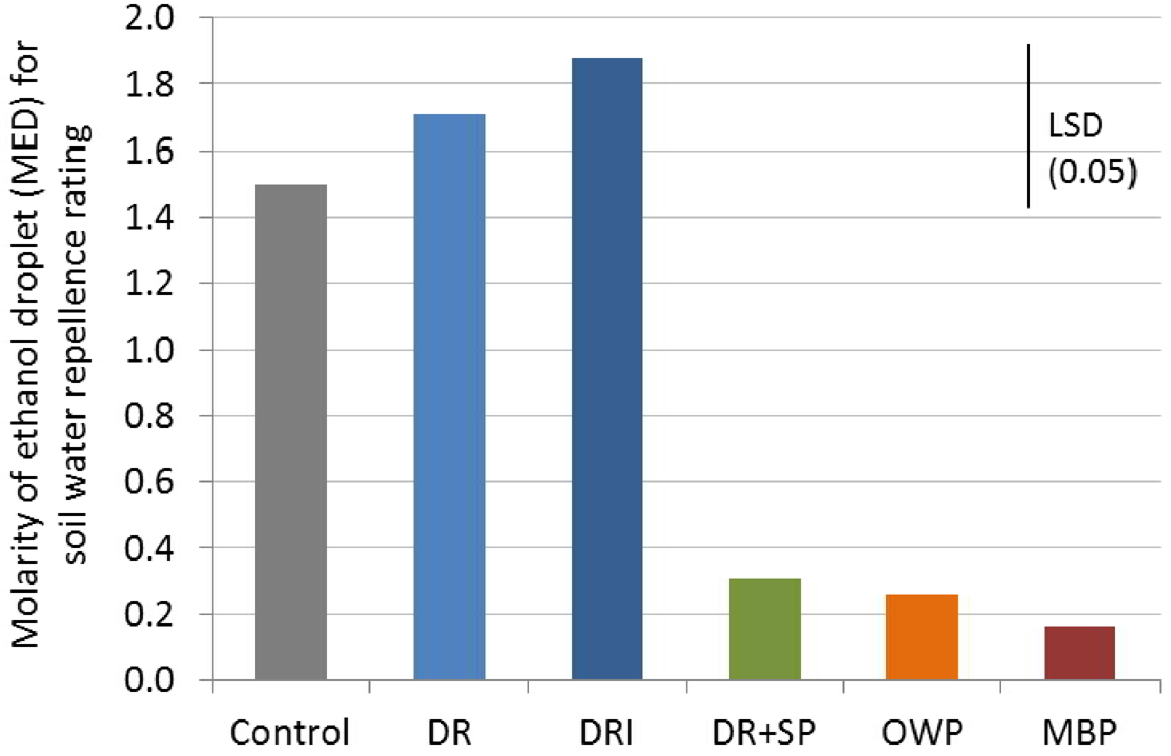
Deep soil mixing and inversion

Steve Davies, Giacomo Betti, Tom Edwards, David Hall,
Glenn McDonald, Craig Scanlan, DPIRD

Tim Boyes, agVivo

Soil water repellence



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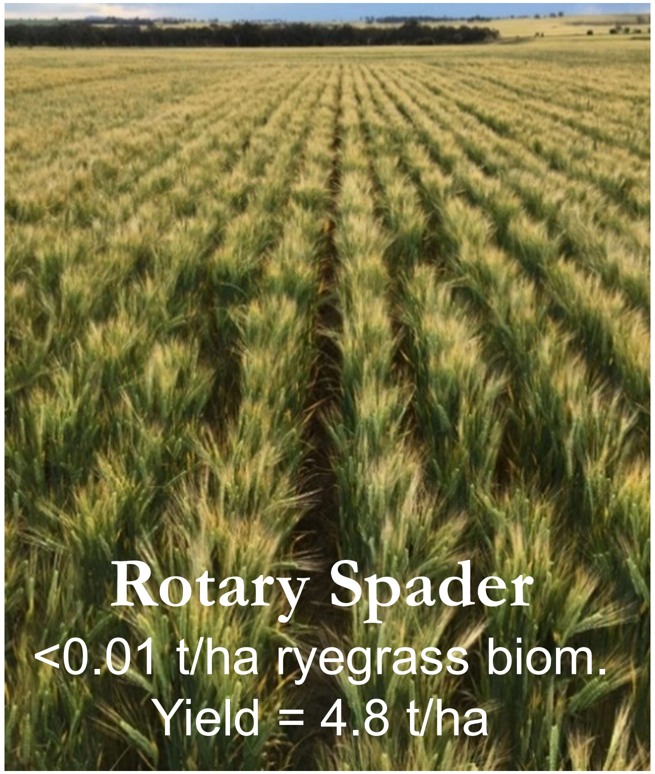
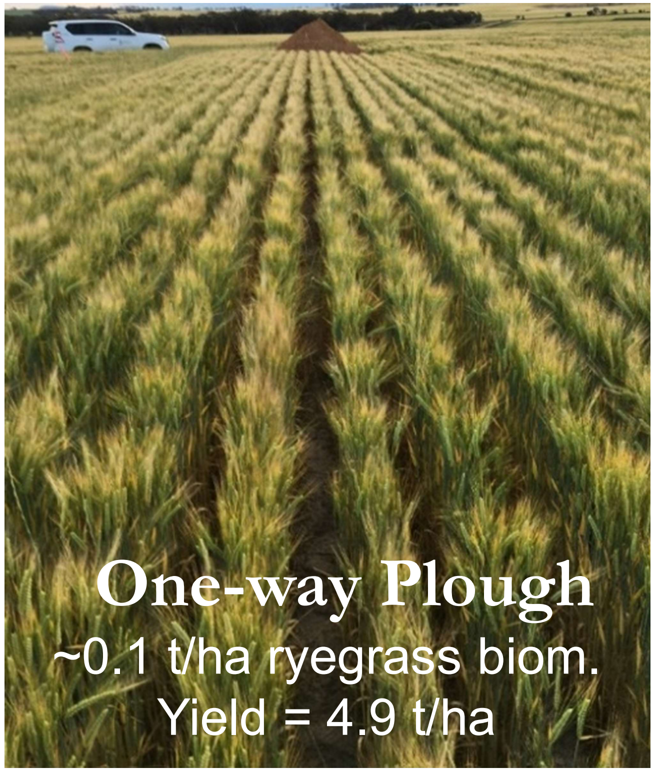
Mild

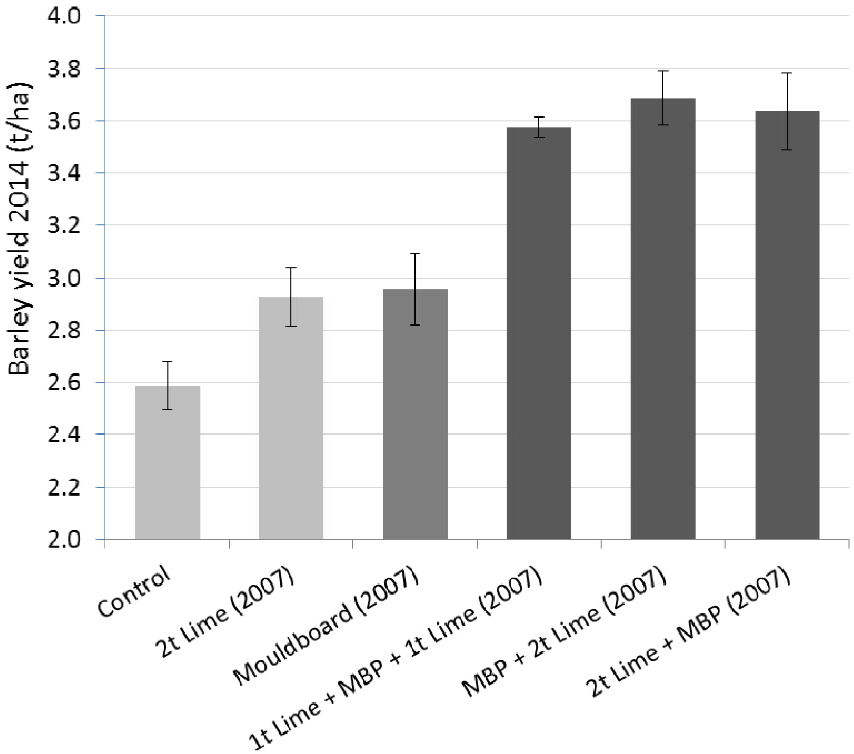
Moderate

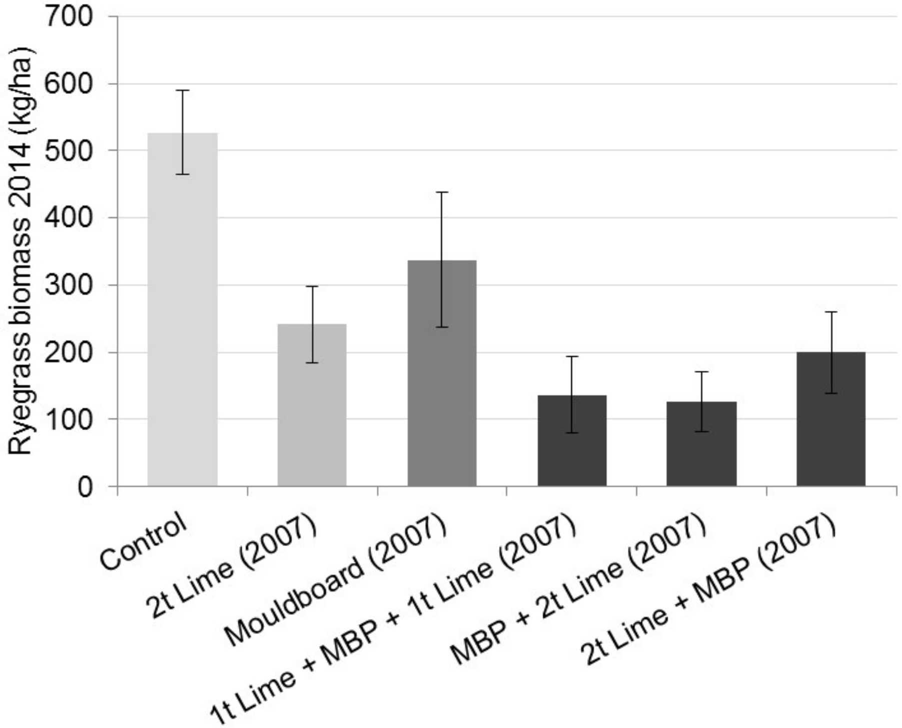
Severe


Weeds
Control
1 t/ha ryegrass biomass
Yield = 3.6 t/ha

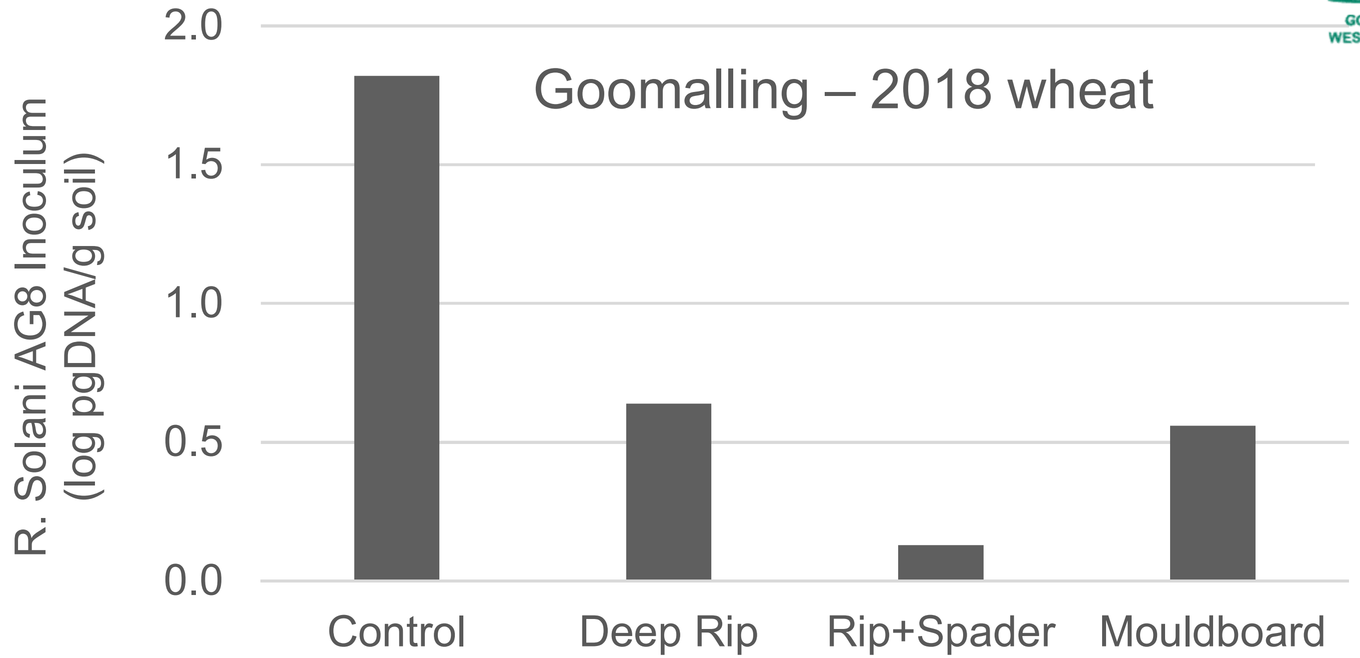

Rotary Spader
<0.01 t/ha ryegrass biom.
Yield = 4.8 t/ha

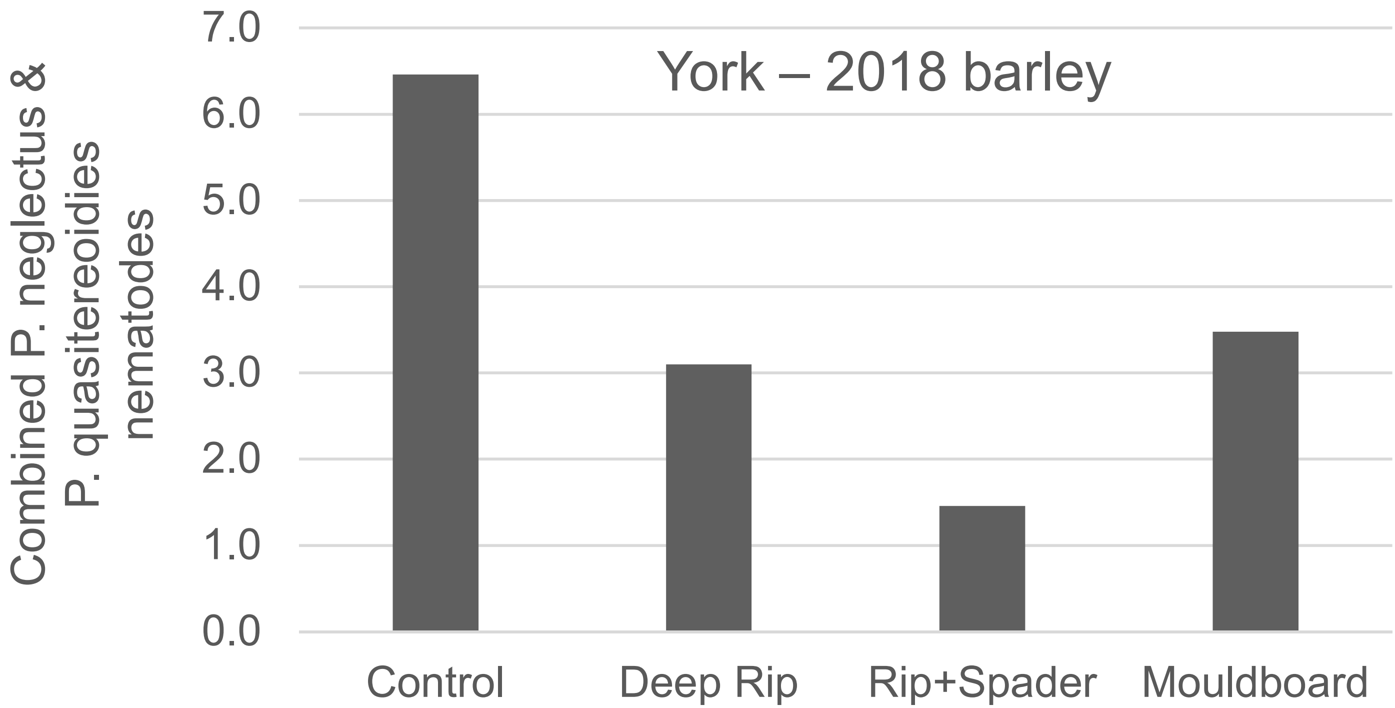

One-way Plough
~0.1 t/ha ryegrass biom.
Yield = 4.9 t/ha


Barley yield 2014 (t/ha)
4.0
3.8
3.6
3.4
3.2
3.0
2.8
2.6
2.4
2.2
2.0
Control
2t Lime (2007)
Mouldboard (2007)
1t Lime + MBP + 1t Lime (2007)
MBP + 2t Lime (2007)
2t Lime + MBP (2007)

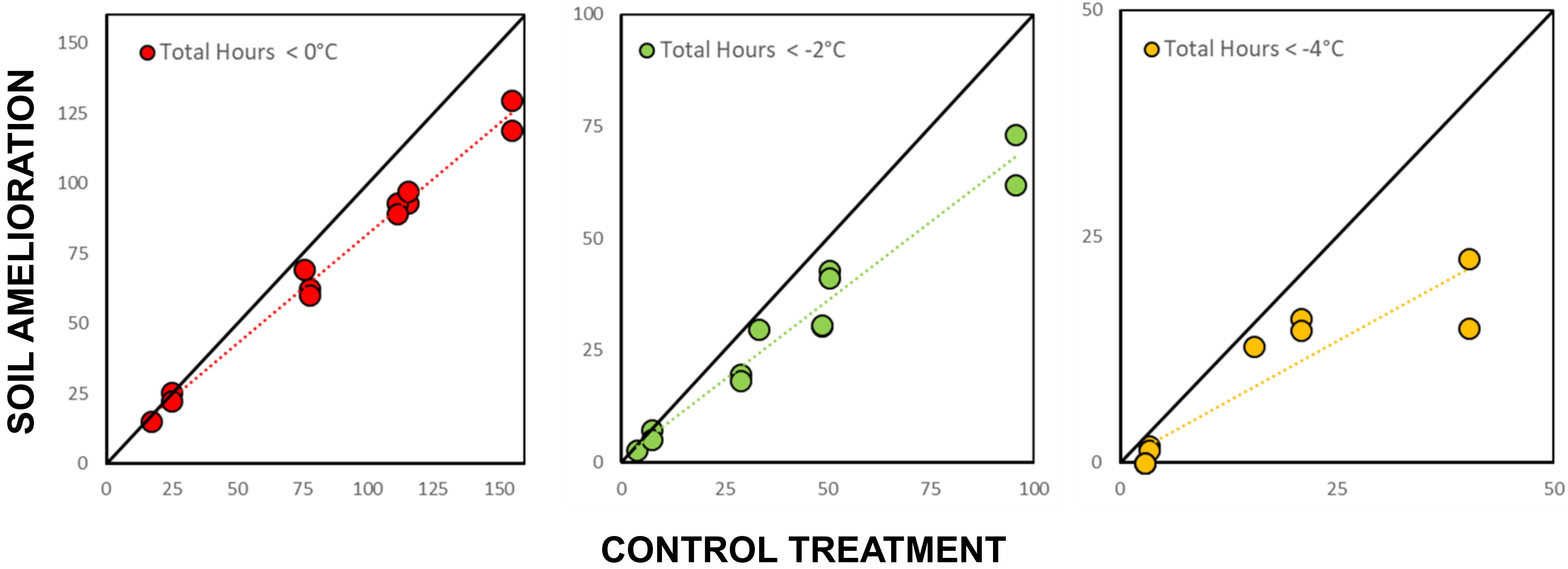

Ryegrass biomass 2014 (kg/ha)
700
600
500
400
300
200
100
0
Control
2t Lime (2007)
Mouldboard (2007)
1t Lime + MBP + 1t Lime (2007)
MBP + 2t Lime (2007)
2t Lime + MBP (2007)

Root disease?





Frost Severity



Frost Damage

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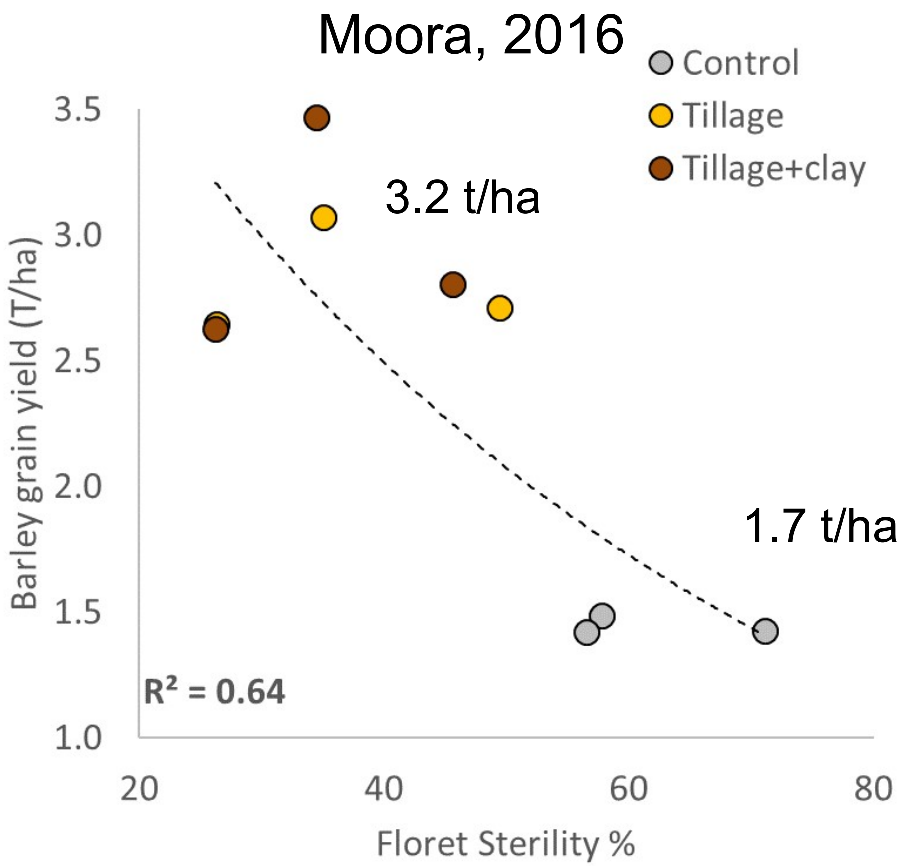
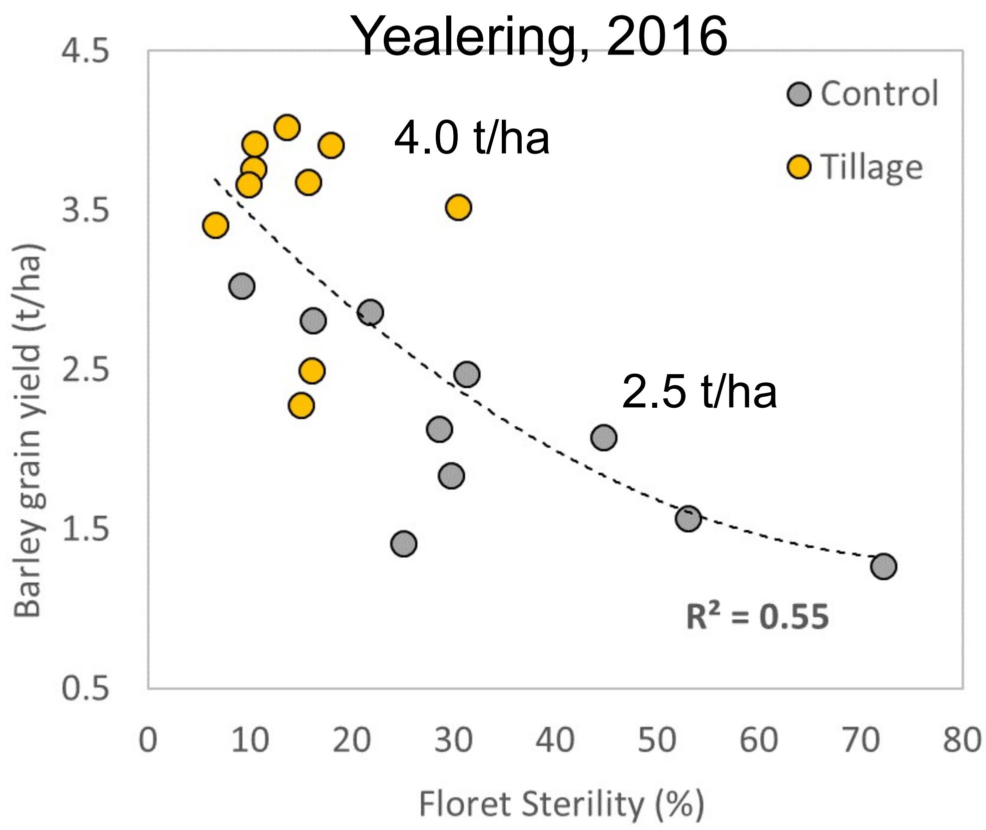
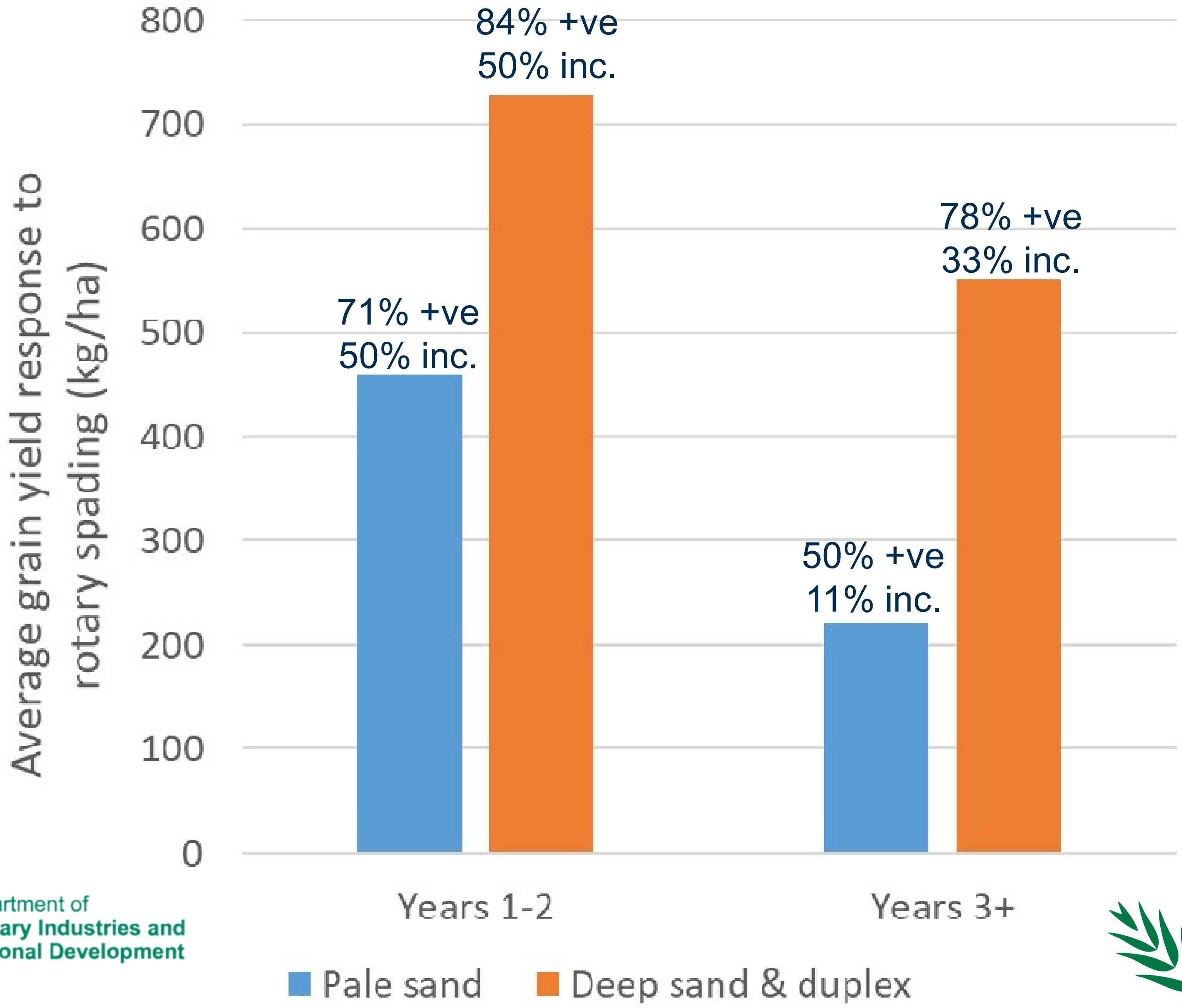
Facey Lime Incorp, 2018

Treat.	Biomass t/ha	HI %	Failed Tillers	Yield t/ha
Spaded	11[b]	37.5[b]	8[b]	4.0[b]
Control	9.5[a]	26.7[a]	65[a]	2.5[a]





Summary 10-Years Rotary Spading Trials



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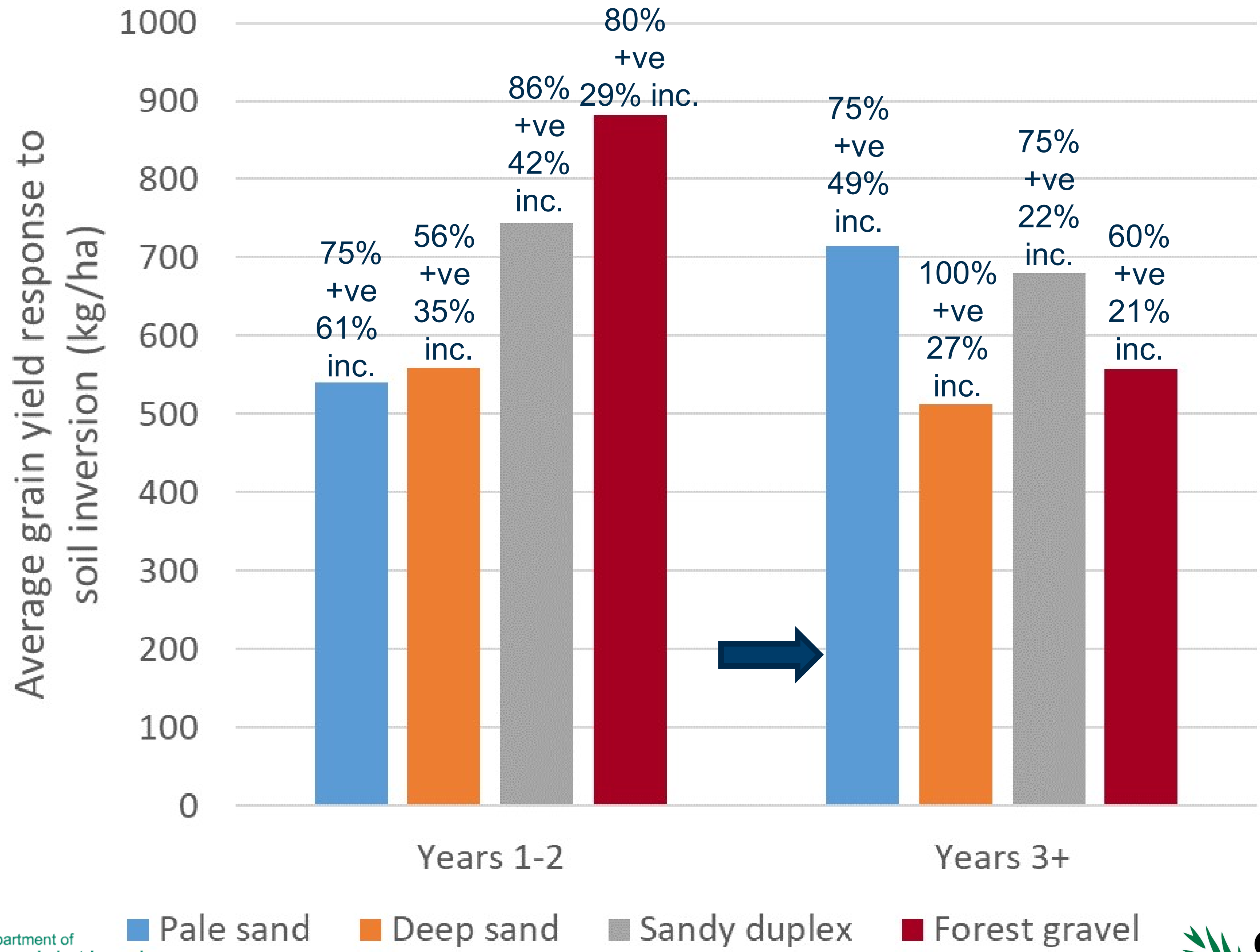
Summary 10-years Soil Inversion Trials



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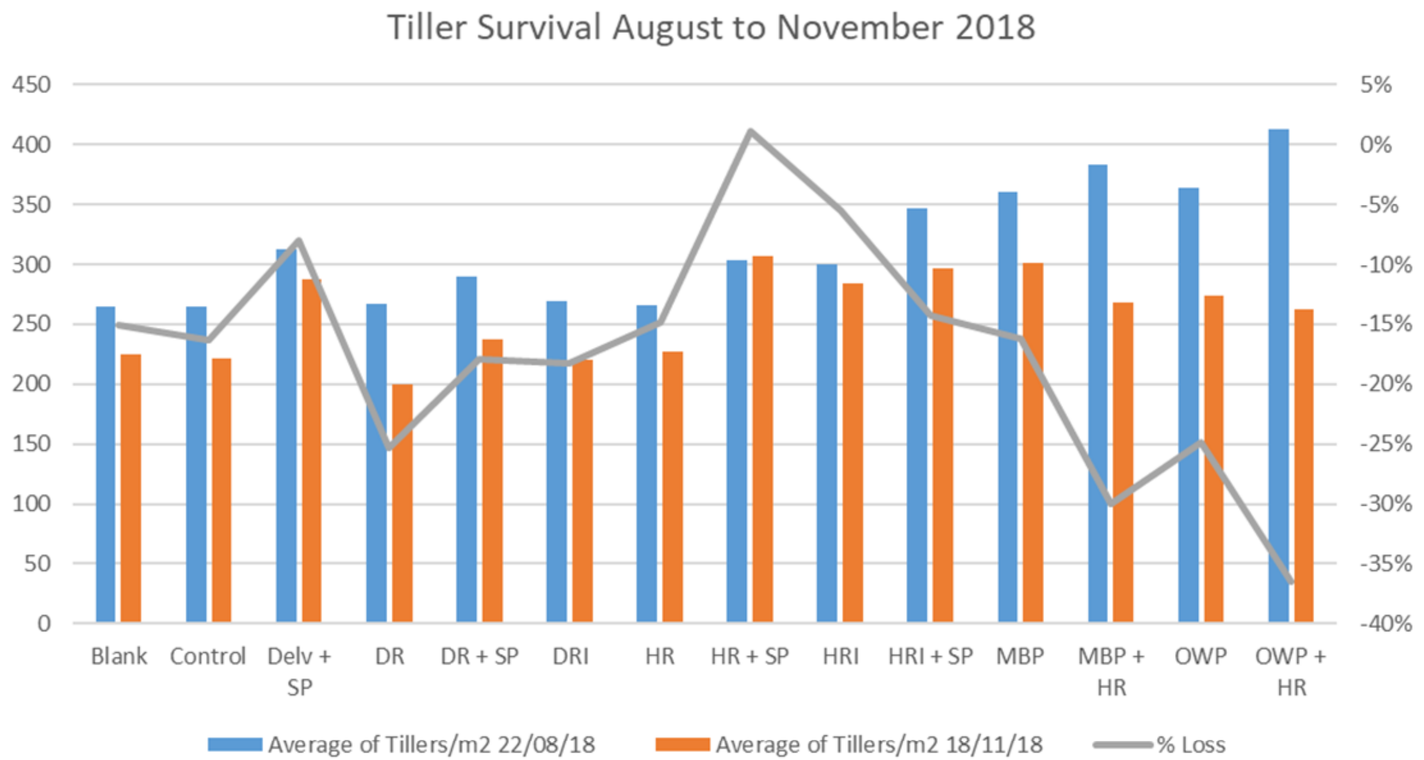
Soil Amelioration and Yield Potential

Location (Soil)	Year	Yield Pot.	% of Yield Potential				
			Control	Ripping	Deeper Ripping	Rip + Mixing	Inversion + Rip
Meckering (Sand over gravel)	2016 2017 2018	3.0 3.7 3.7	70 103 84	83 108 86	100 116 100	100 **138** **124**	97 **143** **135**
Goomalling (Deep sand)	2017 2018	1.2 1.8	35 50	36 58	**125** **88**	117 91	117 72



agVivo advice for agriculture

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Summary – Inversion and Mixing

1. Multiple benefits possible – biotic, climatic and soil constraints
2. Subsequent deeper ripping often strong benefit
   - Average additional 10%, 340 kg/ha
   - Can be up to 700-900 kg/ha
3. Comparing inversion implements
   - Mouldboard tends to outperform one-way plough in 7 of 9 direct comparisons, average 196 kg/ha more
   - Mouldboard vs spader on average minimal difference but can vary between sites
4. Implementation skill and risk for mouldboard higher than some other implements

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ROSA

Ranking Options for Soil Amelioration

Dr Elizabeth Petersen (Liz), Senior Research Officer, DPIRD

Co-authors: Jeremy Lemon and Vilaphonh Xayavong, DPIRD

GRDC Project Numbres: DAW00242, DAW00244, DAW00252

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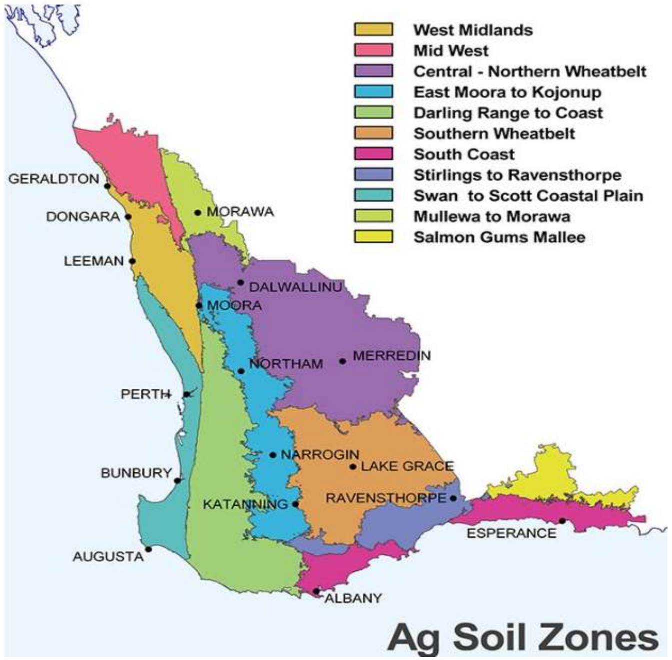
Ranking Options for Soil Amelioration

- Aimed at consultants, agronomists and farmers (not research)
- Preliminary version released in December 2017
- Final version released January 2019
- Available by contacting Jeremy.Lemon@dpird.wa.gov.au



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- **Soil constraints**
  - Topsoil acidity (0-10cm)
  - Subsoil acidity (10-30cm)
  - Soil structure decline
  - Subsoil compaction
  - Water repellence

- **Amelioration options**
  - Liming
  - Gypsum
  - Deep ripping
  - Claying
  - Soil mixing
  - Wetting agents

ROSA

- Costs and benefits accrued over **10-year time period**
- Return on investment ranking based on the **Benefit Cost Ratio**

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Thank you

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