Department of Water and Environmental Regulation

Department of Primary Industries and Regional Development

GOVERNMENT OF WESTERN AUSTRALIA

Reducing free-P reduces leaching and runoff risk in P saturated grazed sandy soils

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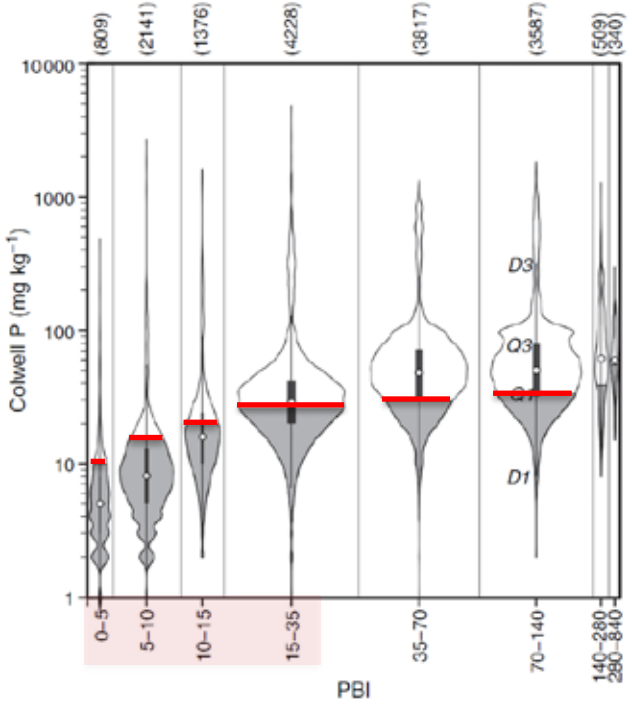
Outline

- Pathology of P losses from sandy soils
- On-farm experiments – modifying risk of P loss with top-dress applications of P sorbing materials.
- Predicting risk of P loss in soils leading up to winter

Pathology of P losses in coastal sands

- PBI of WA coastal dune sands very low – require very little P
- Set and forget fertilizer practices – over application of P to many soils
- P is highly stratified in pastures
- Short-wet winters generate leaching
- Winter saturation of flat landscapes generate runoff



Weaver & Summers 2021. Soil Research, 59, 699–714

Modification of P loss risks

Replicated block experiments with Iron Man Gypsum (IMG) on low PBI, grazed pastures

low P adsorbing sandy soils, seasonally waterlogged pastures

1. 20 t/ha (top-dressed), 60 t/ha (ploughed -in)
2. Lighter top-dressed rates (5, 10 vs 20 t/ha)

What is IMG ?

- Secondary product of titanium ore processing
- Mostly gypsum (80%) with fine iron oxides (up to 18%) & minor manganese
- High phosphate retaining material (up to 20 kg P/tonne)

Assessing effects on runoff

- Rainfall simulator to generate saturated runoff in winter from 1m^2 quadrants
- Post runoff soil P chemistry (0.01M $CaCl_2$-extractable P, Cowell P, PBI). Note: 0.01M $CaCl_2$-extractable P = free-P
- Assessed over 2 winters coupled with whole plot annual soil sampling

Assessing effects on leaching

- Zero tension lysimeter pans on dry rises (for 0-10 cm)
- Full season patterns & flux over 5 years
- Adjacent soil comparison (0.01M $CaCl_2$-extractable P, Cowell P, PBI).

Effects of IMG treatment on soil P characteristics

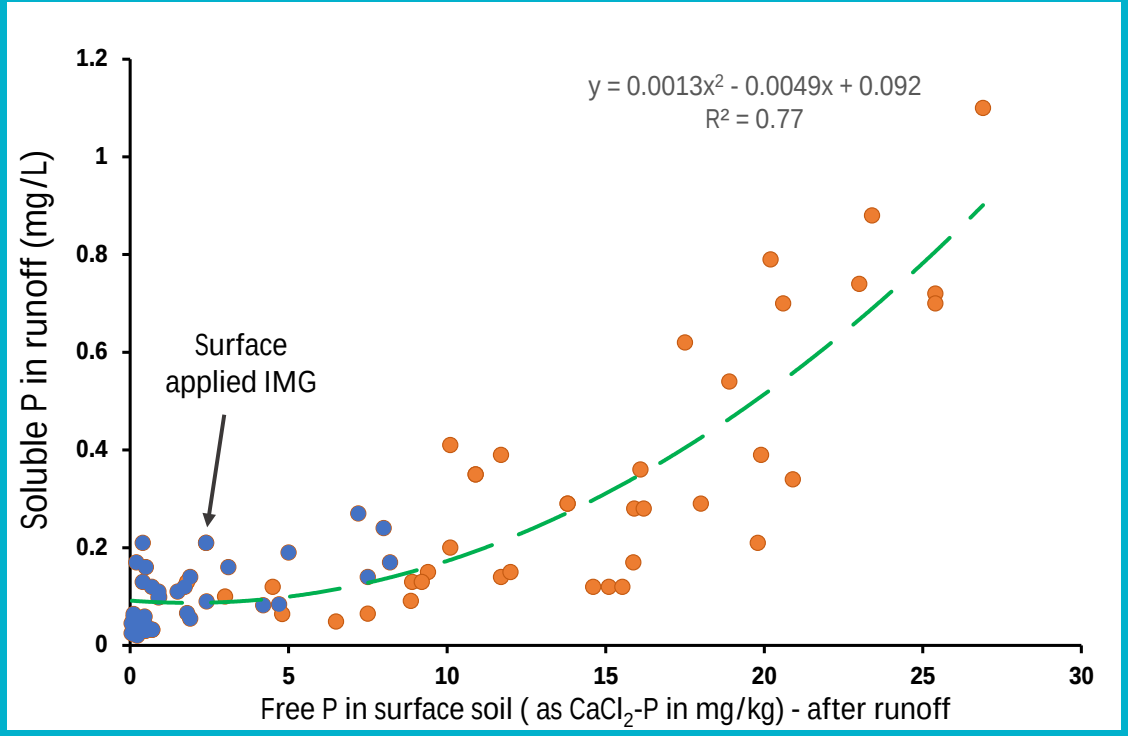
- Stratification
- Effects of IMG treatment
  - Increased surface PBI
  - Surface free-P reduced > 90%
  - No change in plant available P

Runoff quadrant soil properties average over 2 years

Treatment	PBI		Free-P mg/kg (0.01M $CaCl_2$-P)		Colwell P mg/kg	
	0 - 2 cm	0 - 10 cm	0 – 2 cm	0 - 10 cm	0 - 2 cm	0 - 10 cm
Untreated	18 a	10 a	23 a	9.2 c	63 a	22 b
5 t/ha IMG	39 ab	15 a	7.0 b	5.0 cb	82 a	29 b
10 t/ha IMG	42 b	21 a	4.2 b	3.7 b	82 a	36 b
20 t/ha IMG	59 b	17 a	1.4 b	2.5 b	71 a	22 b

Soluble P loss in runoff

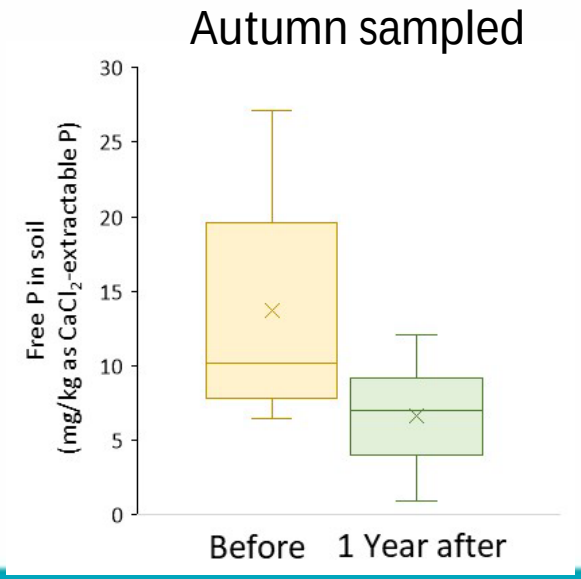
- Immediate reduction in P losses - somewhat rate dependent
- Reduced runoff P a function of free-P in surface soil (0-2cm) – at quadrant scale

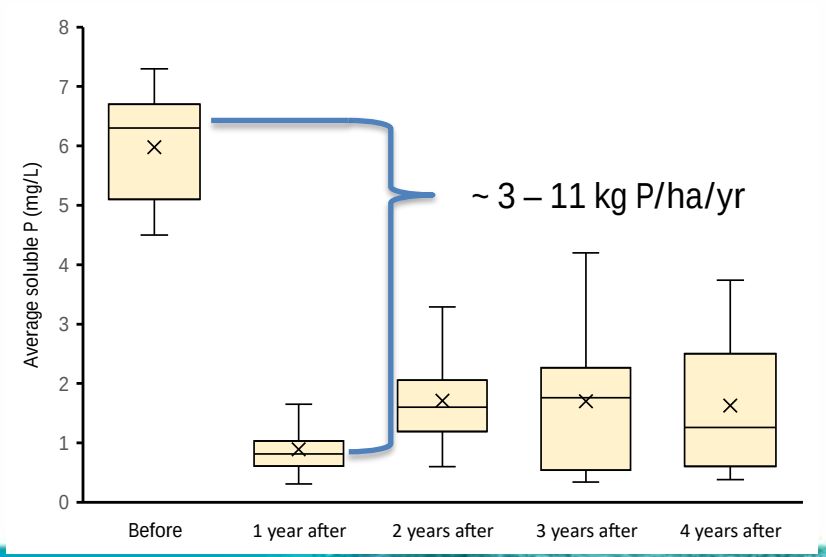


82 runoff assays over 2 years

Paddock scale effects – wet area runoff

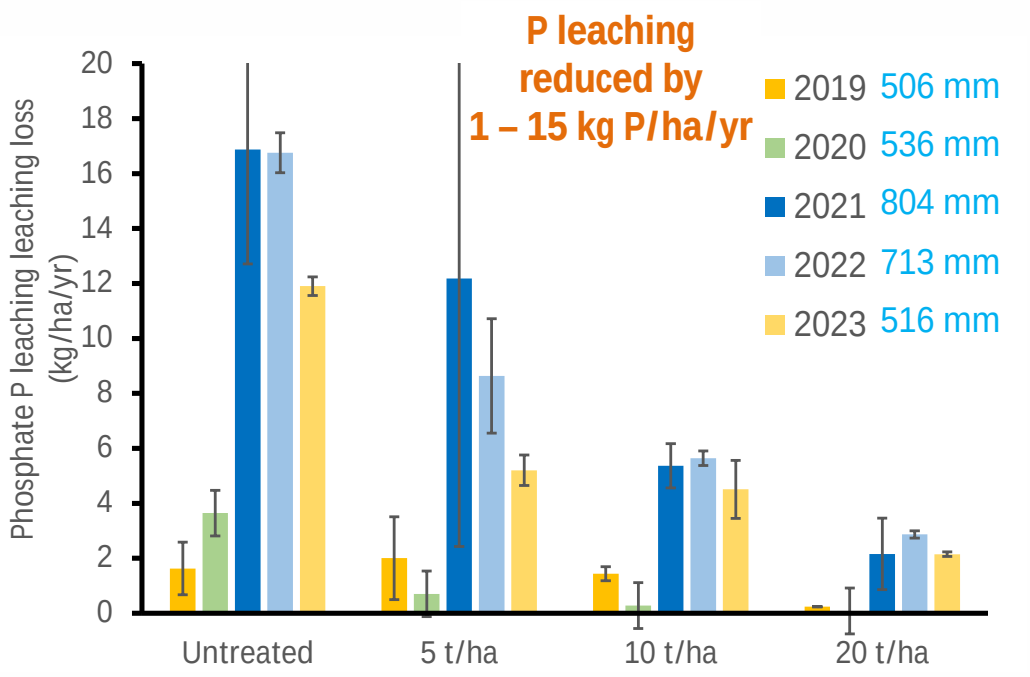
- IMG spread at 20 t/ha on 12 ha of paddocks with grey sands (PBI <30)





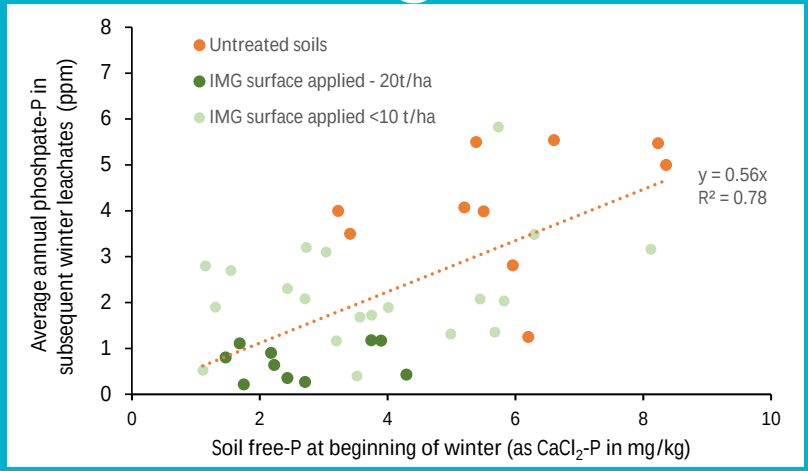
P leaching following single surface application of IMG

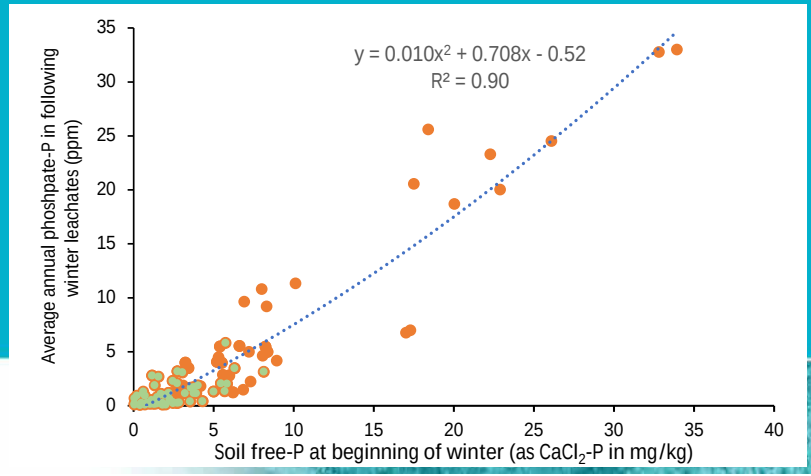
Targeting surface few cm can reduce topsoil P leaching loss



P loss by leaching

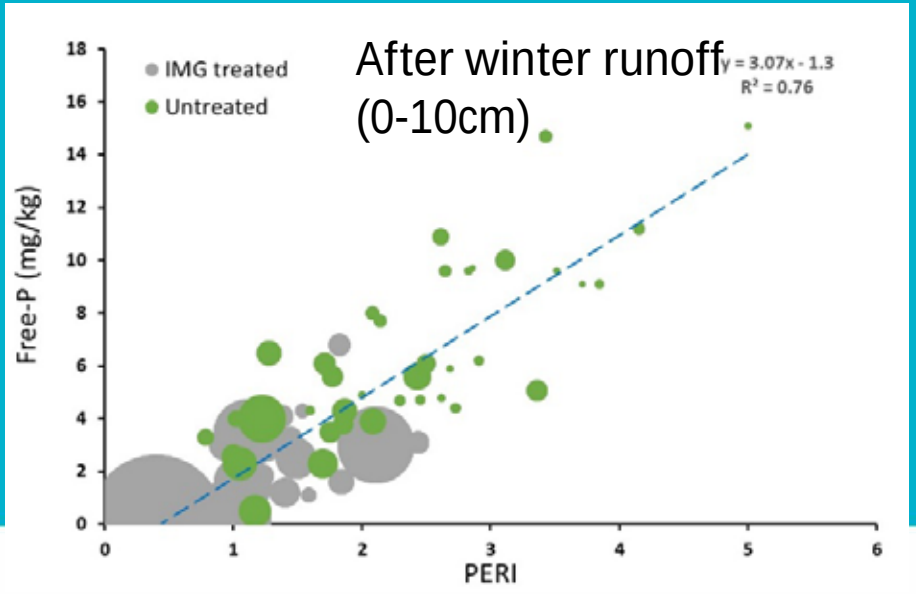
- Pre-winter free-P (0-10 cm) reasonable predictor of the following winter leach P concentrations
- Effects of IMG via reduced free-P at the soil surface
- Variation reflects uniformity of coverage effects of low rates ?
- Extends across soil types

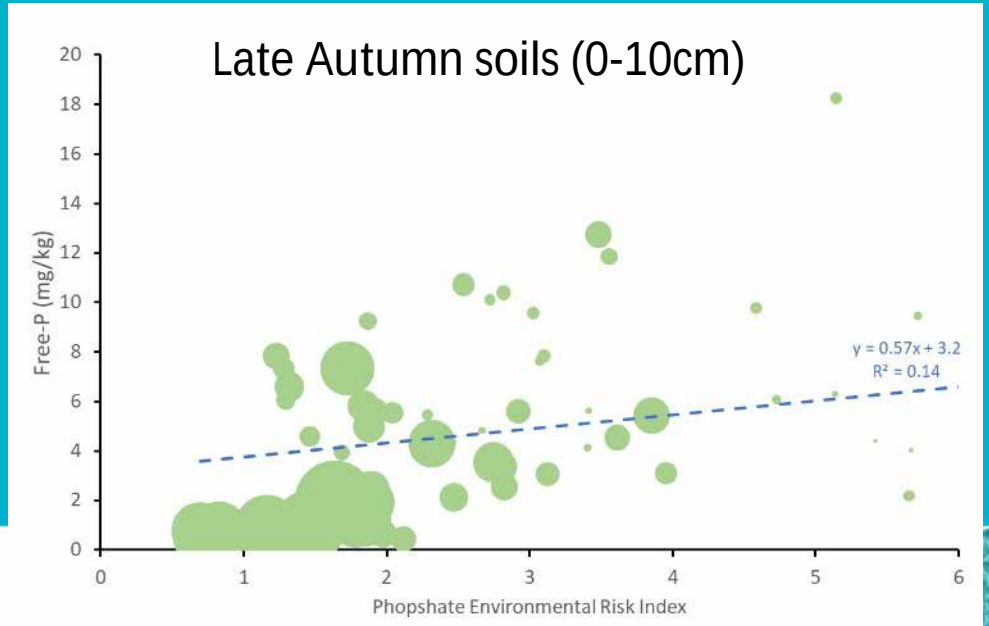




Can pre-winter agronomic tests predict free-P ?

- Phosphorus Environmental Risk Index – Colwell P/PBI (after Moody 2001)
- Winter PERI reflects free-P – during active P leaching
- Summer PERI is a poor indicator of free-P
- PBI measurement errors confound use of PERI





Conclusions

- Free-P ($CaCl_2$-extractable) in sandy soils is a strong predictor of the concentrations of P that can be lost by leaching or runoff.
- Reducing free-P using high P adsorbing materials reduces P at risk of loss - effects extend > 4 years.
- Indirect measures of free-P such as the Phosphate Environmental Risk Index (PERI) poorly reflects free-P in very low PBI soils but might provide a might provide a broad level indicator of paddocks with risks of high P loss

- Incentivising farmer adoption of surface applied amendments has the potential to achieve significant reductions in P loss from farmed sandy soils to the environment.

Questions