

Can DGT soil test methods improve fertiliser P decisions?

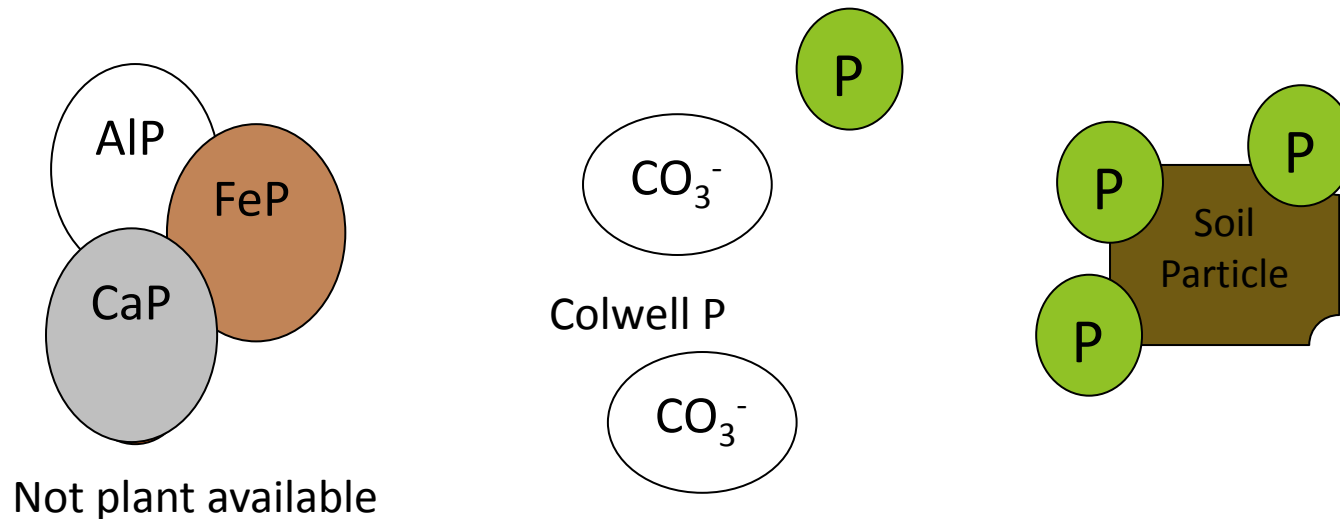
Sean Mason

Colwell P - the issue?

- ❑ Big P nutrition problem in South Australia
- ❑ Calcareous soils (CaCO_3 % > 5)
- ❑ Colwell P > 40mg/kg, above critical levels
- ❑ Large responses to P applications
- ❑ Needed another soil P test

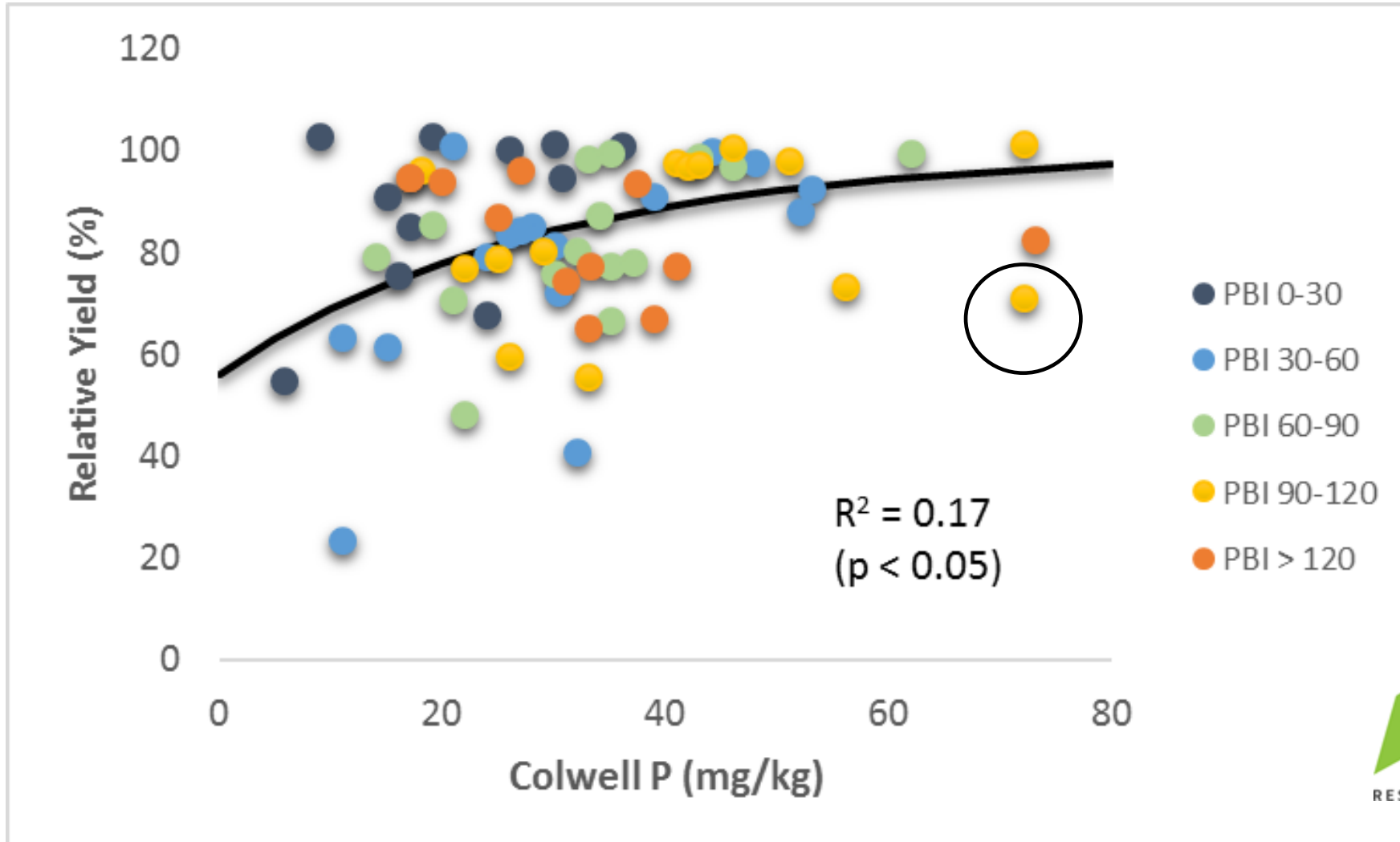
Colwell P - the issue?

- ❑ **Colwell P (1963)** - 0.5M bicarbonate extract (@ pH 8.5)
soil to solution ratio - 1:100, shaking time - 16 hours
- ❑ **Olsen P (1954)** - 0.5M bicarbonate extract (@ pH 8.5)
soil to solution ratio - 1:20, shaking time - 30 mins
- ❑ **Bray P** - 0.03M Ammonium Fluoride in 0.025M HCl (@ pH 3.0)
soil to solution ratio - 1.43:10, shaking time - 60 seconds



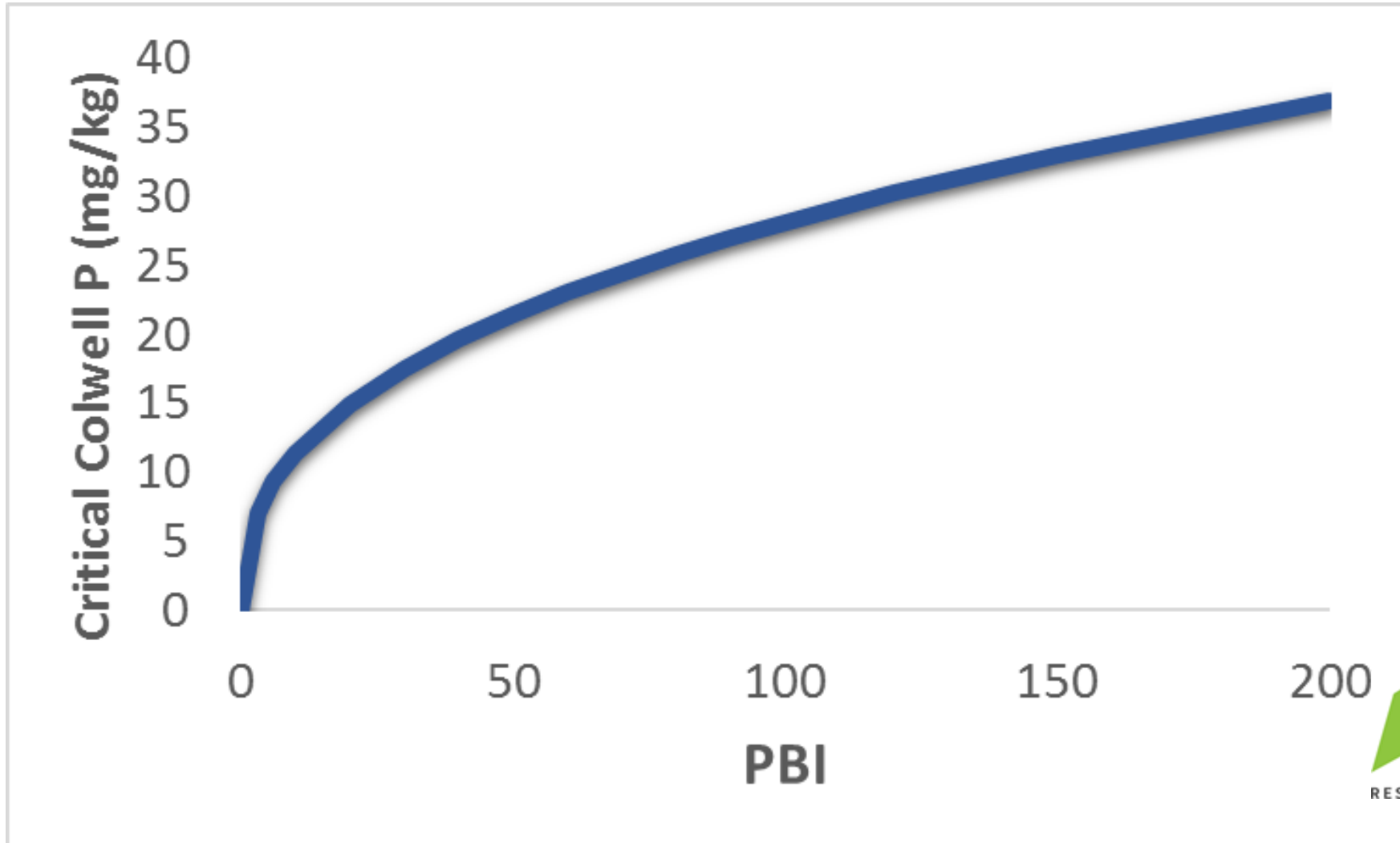
Colwell P - the issue?

Field validation - wheat trials (2006-2015)



Colwell P - the issue?

- Needs PBI correction



What is DGT?

Diffusive Gradients in Thin-films

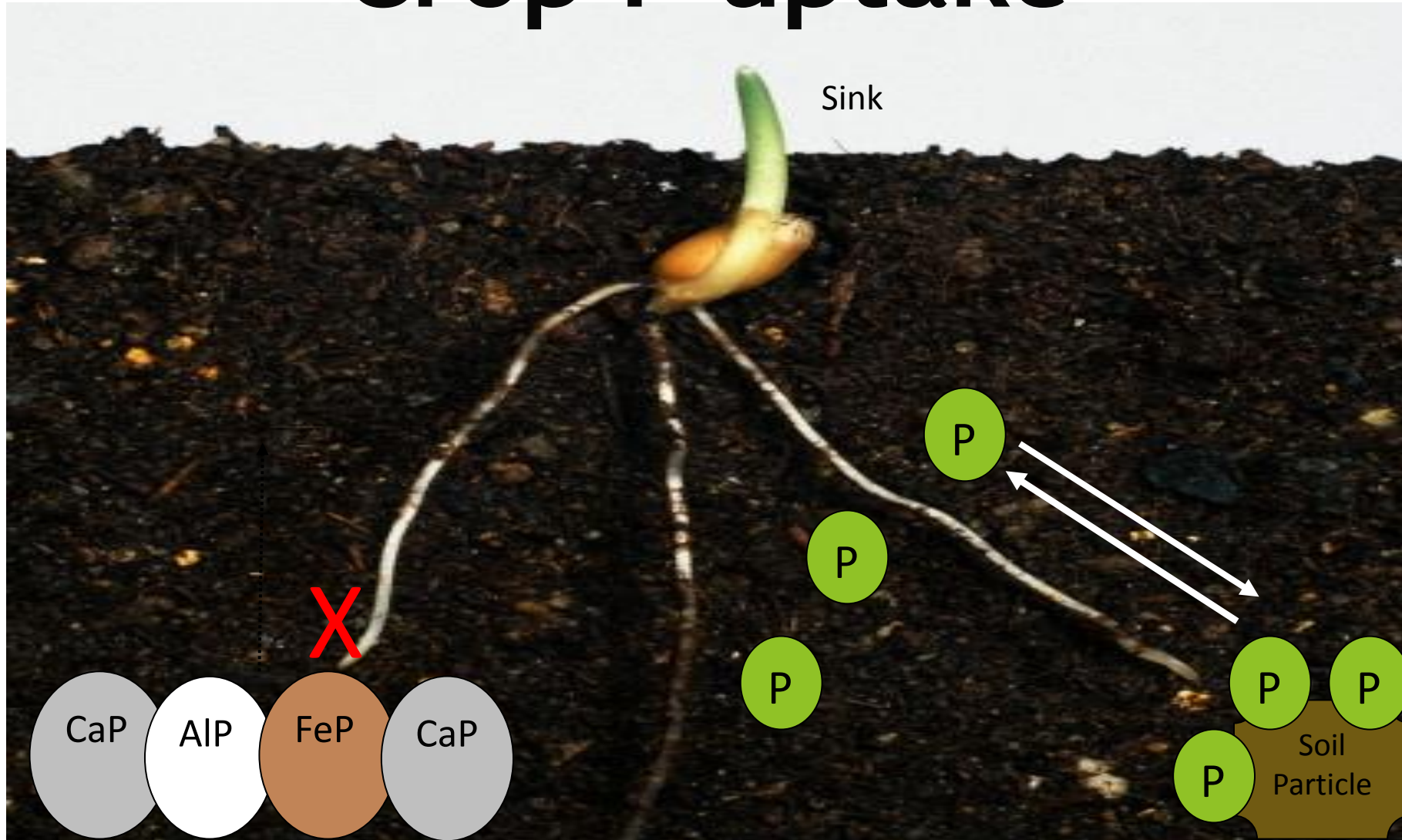
- ❑ Mimics the action of P uptake by a plant
- ❑ Plants take up P by diffusion
- ❑ What is diffusion?

Nutrient	Diffusion %	Interception %	Mass flow %
Phosphorus	95	2	3
Nitrogen	20	2	78
Potassium	80	2	18
Sulphur	0	1	99
<i>Barber 1984 - Corn in an alfisol</i>			

Diffusion

- Diffusion is the net movement of molecules or atoms from a region of high concentration (or high chemical potential) to a region of low concentration (or low chemical potential). This is also referred to as the movement of a substance down a concentration gradient.

Crop P uptake



What is DGT?

Measures the diffusion component of P

- 1) We need a sink = Ferrihydrite (iron) layer - binds P (sink)
Specific for P
- 2) We need to control P movement to sink = Diffusive layer - Restricts initial flux of P
- 3) Filter paper - Protection/restricts contamination



What is DGT?

Measures the diffusion component of P

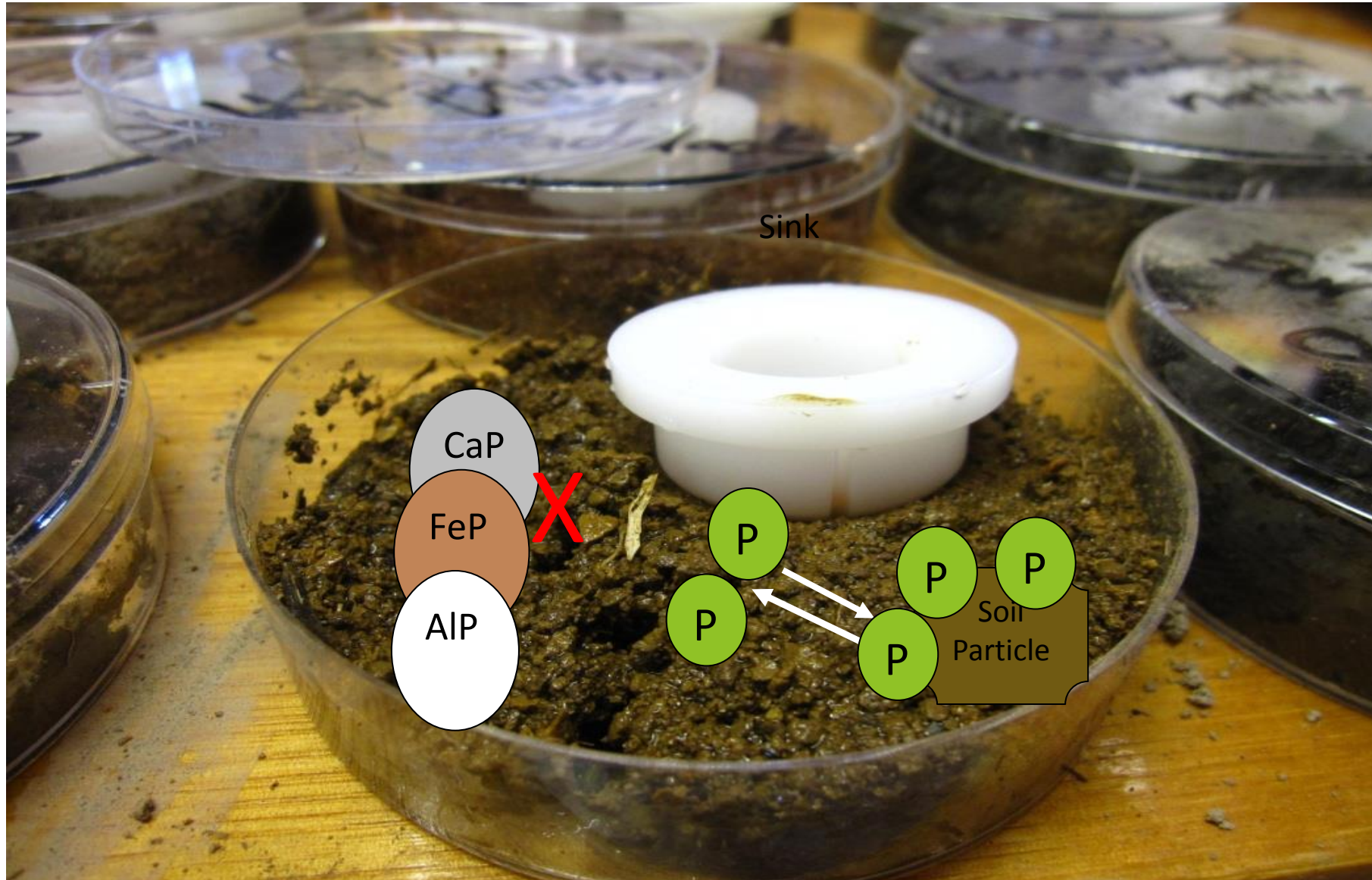
Measurement conditions

- 1) Extractant medium - Water
- 2) Realistic moisture conditions = Soil: water - 100 % WHC
- 3) Deployment time - 20-24 hours
- 4) Ferrihydrite layer removed and eluted in 1M HCl



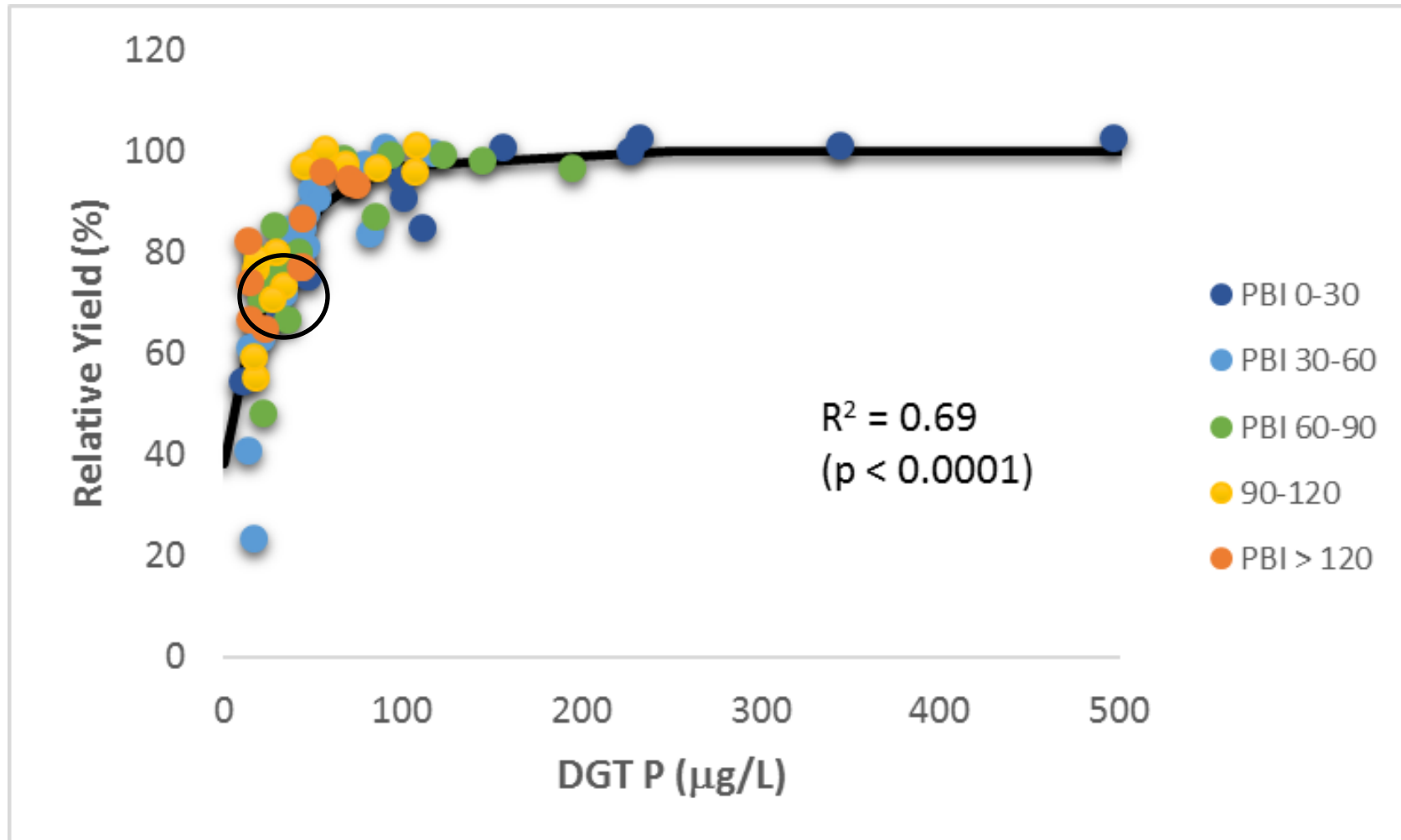
What is DGT?

Measures the diffusion component of P



DGT - does it work?

- Field validation - wheat trials (2006-2015)



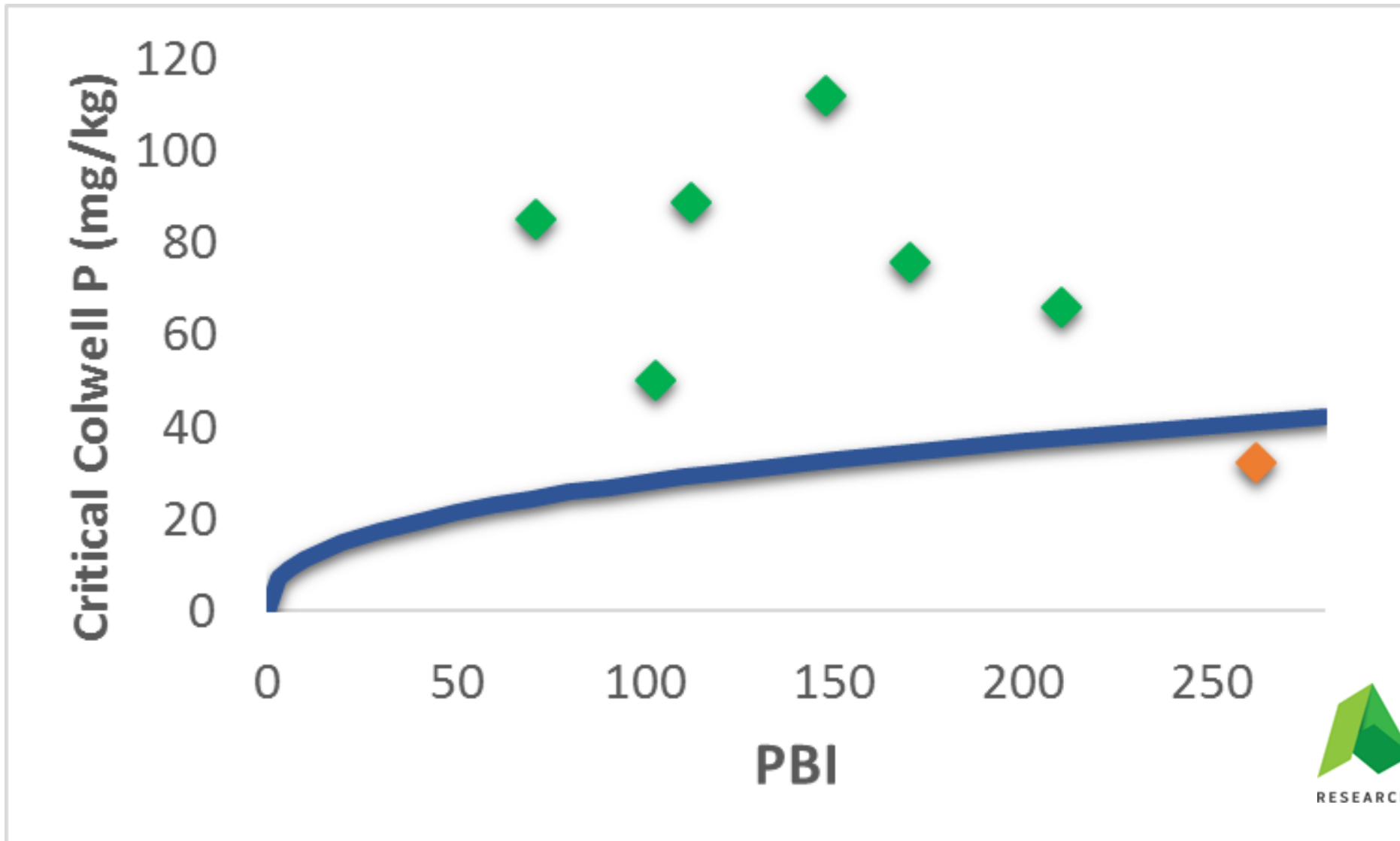
DGT - relevance to W.A?

- ❑ Selected P nutrition problem in Western Australia
- ❑ Forest gravel soils (high in Al/Fe)
- ❑ Colwell P > 40mg/kg, above critical levels
- ❑ Large responses to P applications
- ❑ Need another soil P test?

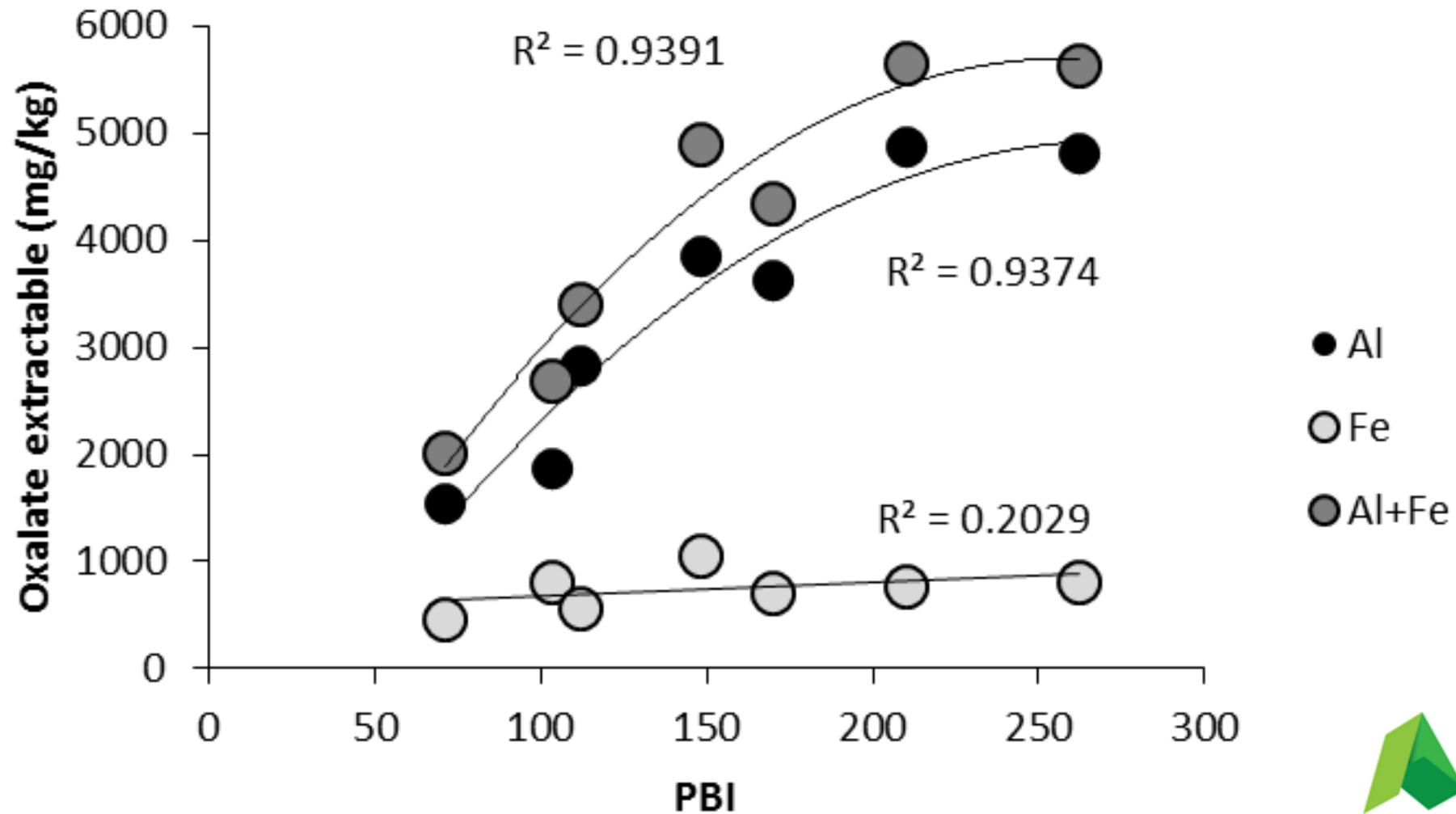
DGT - relevance to W.A?

Soil	pH	TOC	PBI	Al _{ox}	Fe _{ox}	Clay	Silt	Sand	BSES P	Colwell P	Mehlich-3 P	Resin P	DGT P
	H ₂ O	%		mg/kg	mg/kg	%	%	%	mg/kg	mg/kg	mg/kg	mg/kg	µg/L
1	6.6	4.7	103	1880	821	6	5	76	174	50	74	18	34
2	5.9	6.9	262	4810	822	12	4	67	100	32	26	2	10
3	6.4	4.7	210	4880	782	8	4	77	257	66	89	16	27
4	5.8	6.5	112	2830	581	9	3	76	172	89	117	19	27
5	6.6	2.6	71	1560	468	4	4	87	225	85	155	44	47
6	6.0	6.9	148	3850	1060	5	4	78	351	112	149	31	45
7	4.9	3.9	170	3640	715	12	5	70	153	76	81	9	14

DGT - relevance to W.A?

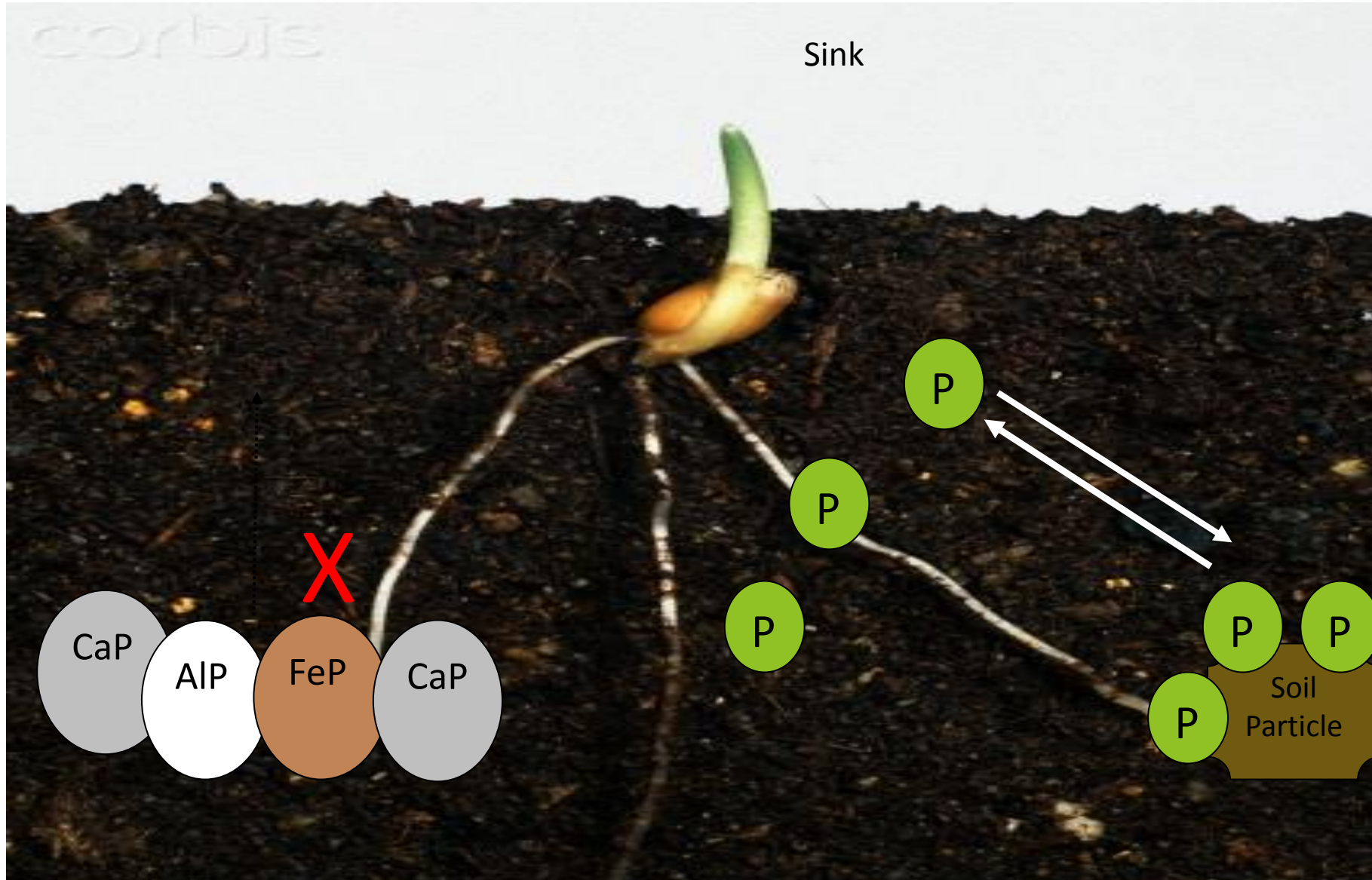
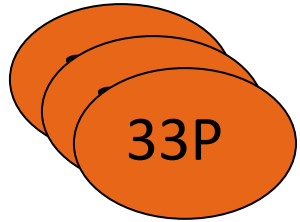


DGT - relevance to W.A?



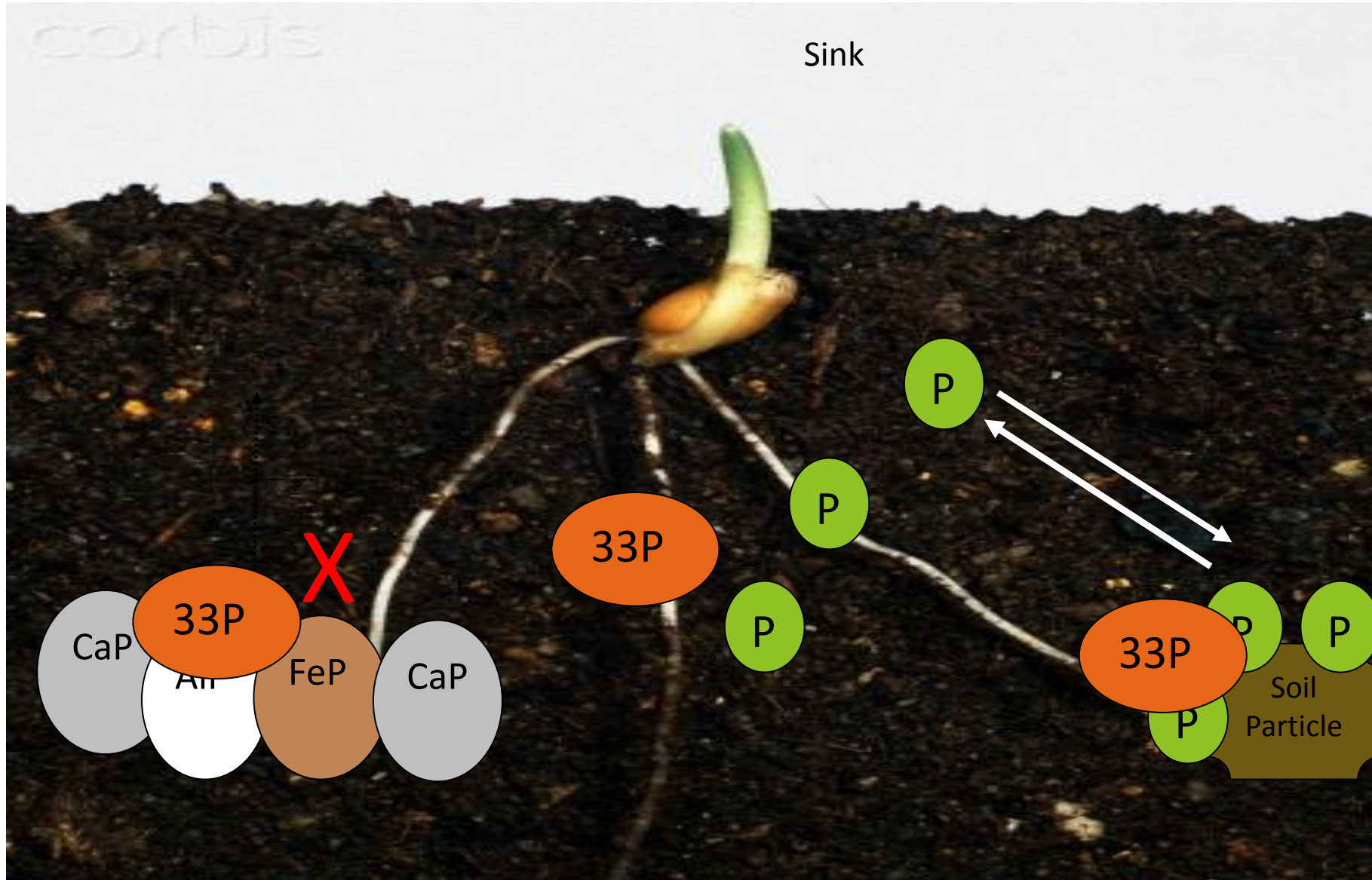
DGT - relevance to W.A?

- What did we do? Isotopic dilution technique



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DGT - relevance to W.A?

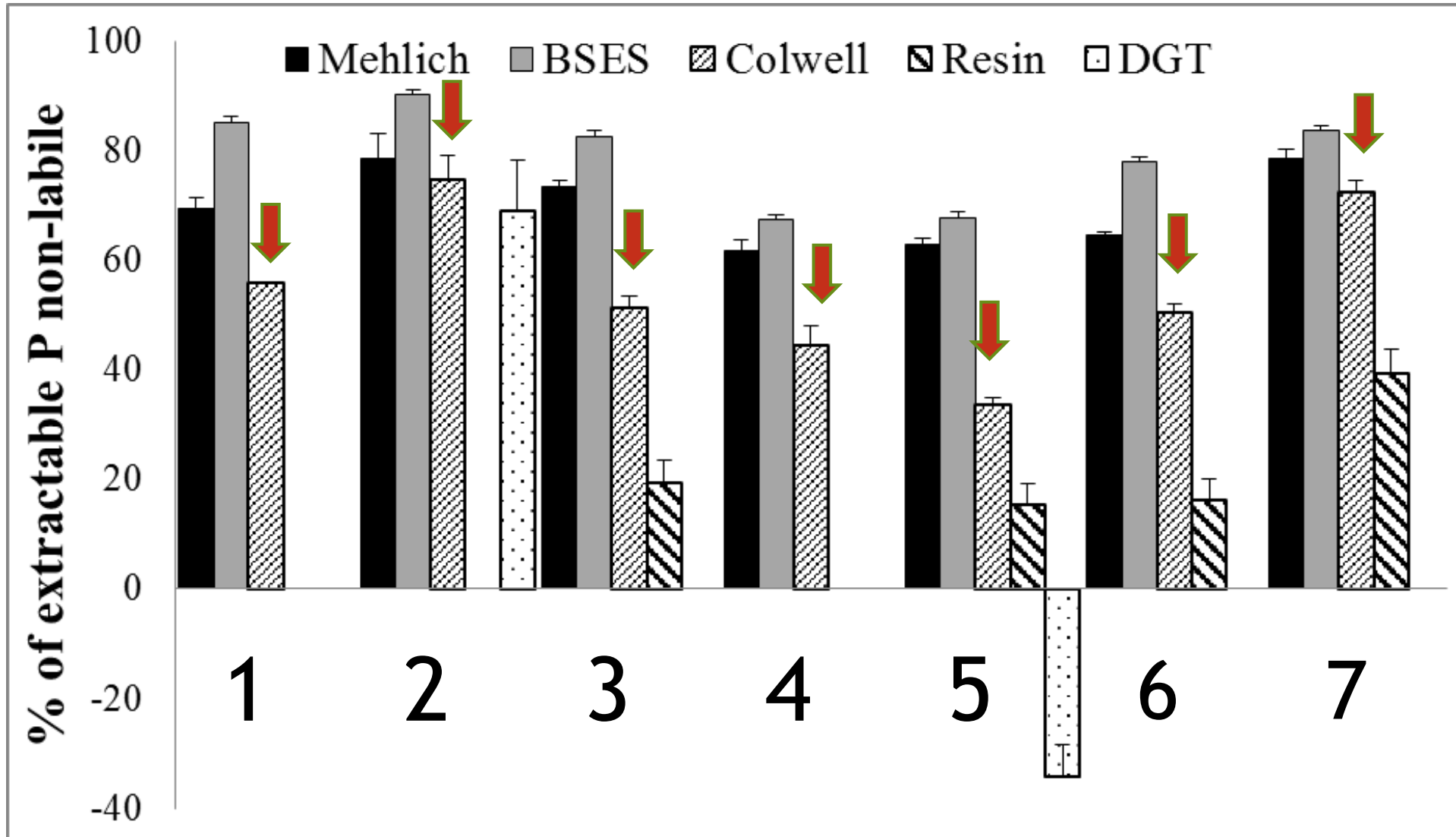
- ❑ Results in a signature of P availability in the plant - $^{33}\text{P}:$ ^{31}P (Specific Activity - SA)
- ❑ If a soil test is accurate then $^{33}\text{P}:$ ^{31}P signature should be the same
- ❑ So what happened?

DGT - relevance to W.A?

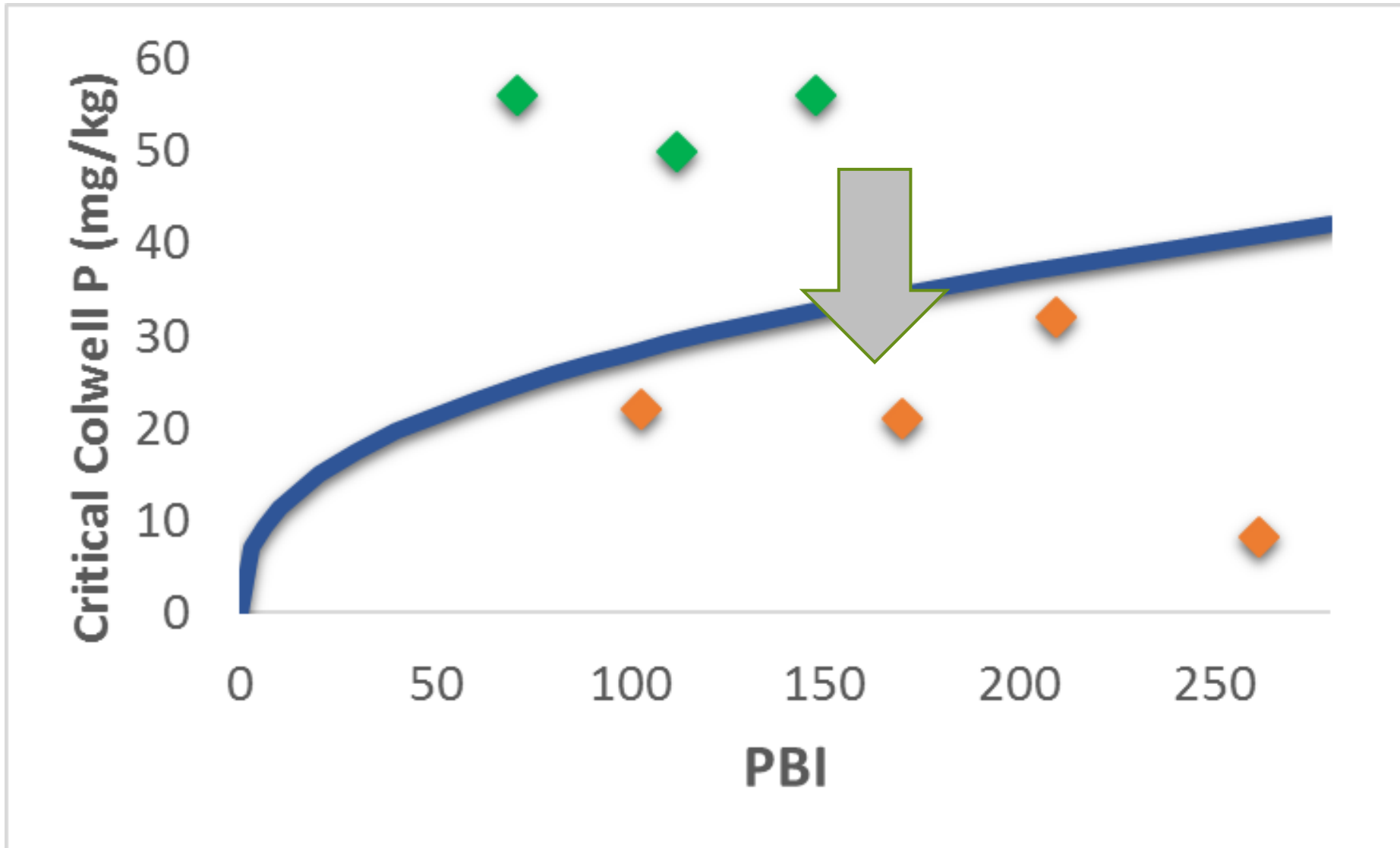
Soil	SA Plant/SA Soil test				
	BSES	Colwell	Mehlich	Resin	DGT
1	6.8a*	2.3c*	3.3b*	1.5d	1.4d
2	10.9a*	4.2b*	5.2b*	1.9b	3.8b*
3	5.8a*	2.1c*	3.8b*	1.2d*	1.5d
4	3.1a*	1.8c*	2.6b*	1.2d	0.8e
5	3.1a*	1.5c*	2.7b*	1.2d*	0.8e*
6	4.6a*	2.0c*	2.8b*	1.2d*	1.0d
7	6.2a*	3.7b*	4.7b*	1.7c*	1.4c
Mean	5.8	2.5	3.6	1.4	1.5

We want a value of 1

DGT - relevance to W.A?



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DGT - Future work

- ❑ Glasshouse work - Isotopic technique with applied P
- ❑ Impact of gravel content on P availability
- ❑ P response trials in the field over three years

Take home messages

- ❑ Colwell P can extract significant amounts of non-labile P in soils where high amounts of P are fixed to Al/Fe/Ca
- ❑ DGT soil test for P offers an improved alternative on problematic soil types
- ❑ Further investigation is warranted on applicable W.A. soil types especially in field conditions