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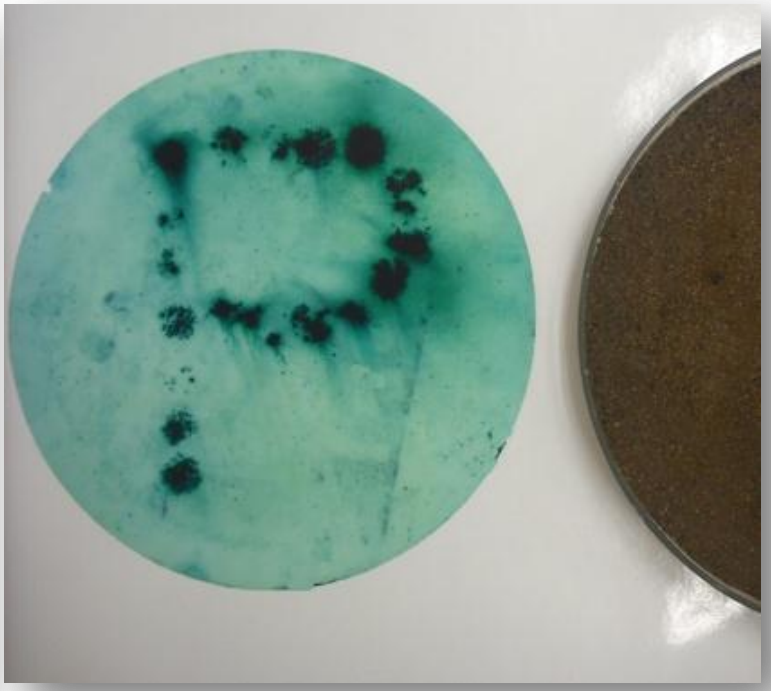


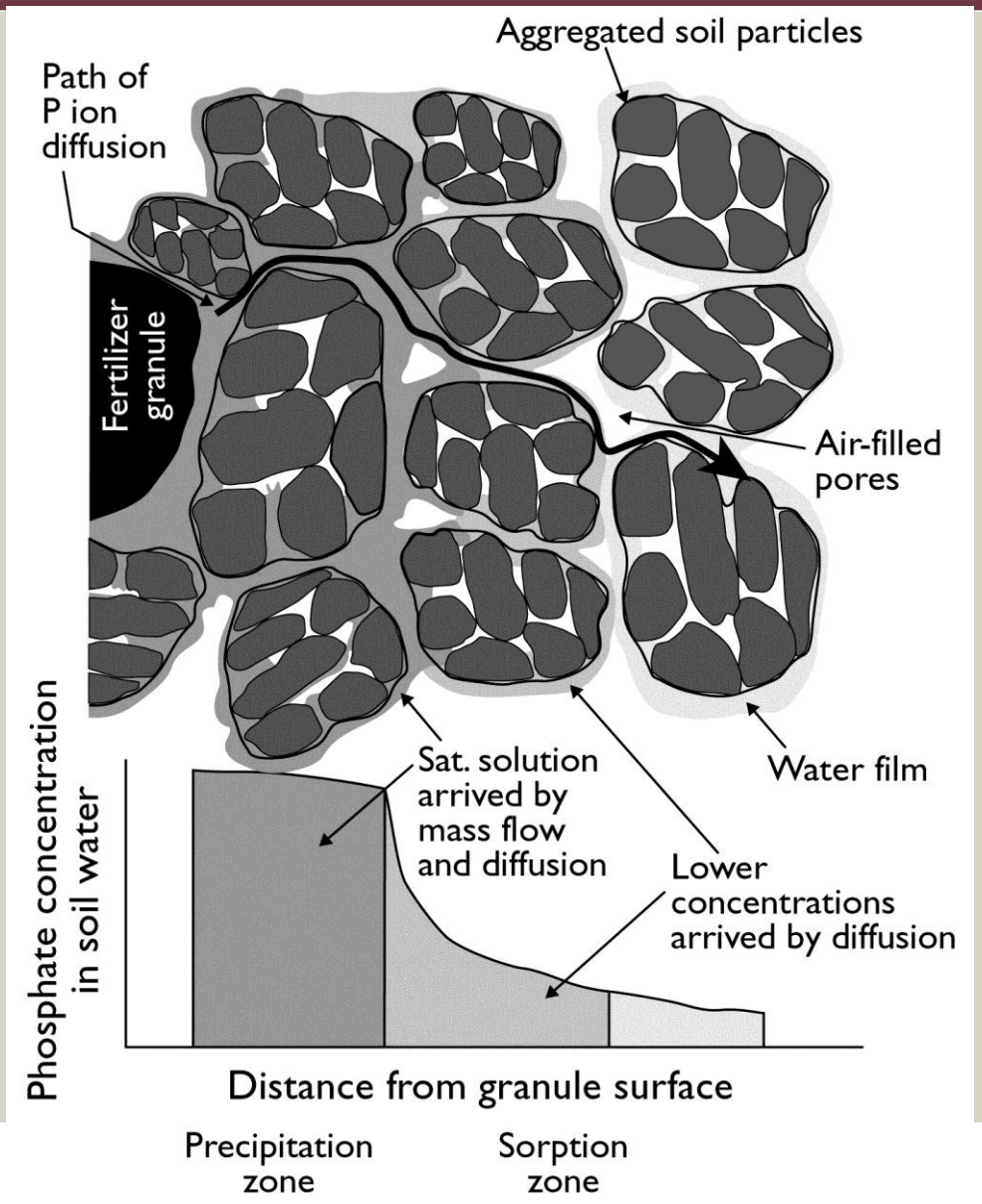
Effect of moisture on fluid and granular P diffusion in different soils

D. Montalvo, F. Degryse, **Sola Ajiboye** & Mike McLaughlin

Introduction

- Strong fixation of P in soils is well known to reduce efficiency of P fertilizers
- Fluid P fertilizers outperform granular fertilizers in calcareous soils (Holloway et al., 2001)
  - attributed to reduced precipitation and enhanced diffusion (Lombi et al, 2004)

Introduction....

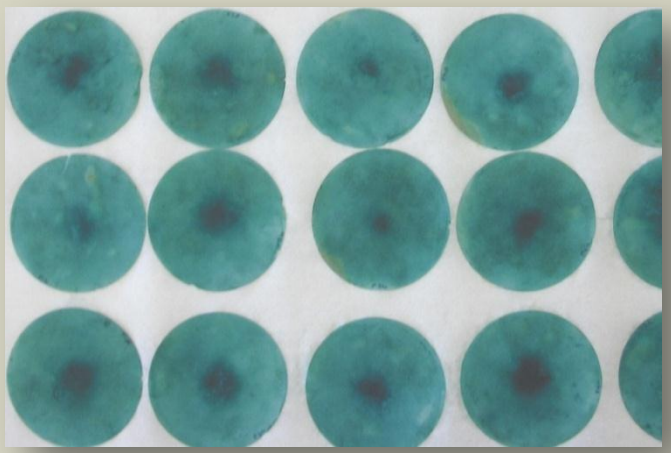


Introduction

- Strong fixation of P in soils is well known to reduce efficiency of P fertilizers
- Fluid P fertilizers outperform granular fertilizers in calcareous soils (Holloway et al., 2001)
  - attributed to reduced precipitation and enhanced diffusion (Lombi et al, 2004)
- However, effectiveness of fluid fertilizers in **other type of soils** and **different moisture content** is unclear

Objectives

- Investigate diffusion of P from granular and fluid fertilizers in a range of soils, using a newly developed visualisation technique



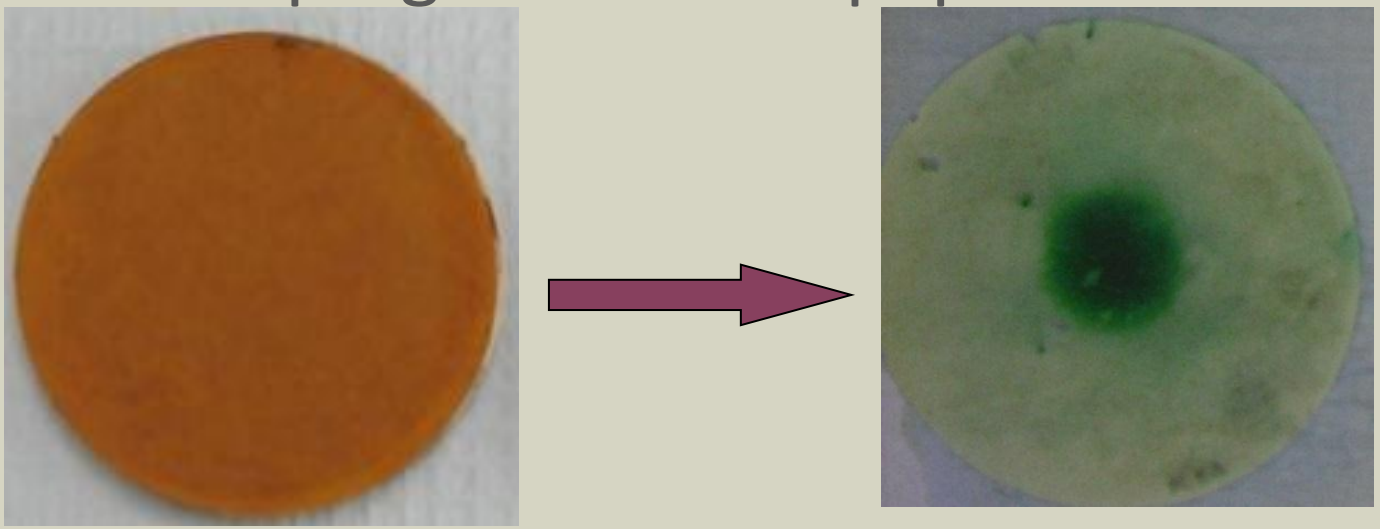
- Investigate how moisture content affects the diffusion of P from granular and fluid fertilizers

Selected soils

Location	Order	pH (H_2O)	Al_{ox}	Fe_{ox}	OC	$CaCO_3$	Clay
			---------- % ----------				
North-NZ	Andisol	5.7	4.20	0.82	8.5	<0.2	7
Mt Schank	Andisol	6.5	1.75	0.82	7.0	<0.2	22
Greenwood	Oxisol	5.9	1.73	0.41	4.4	<0.2	13
Redvale	Oxisol	6.4	0.23	0.22	1.0	<0.2	61
Kingaroy	Oxisol	5.6	0.23	0.26	1.8	<0.2	41
Pt Kenny	Calcic Inceptisol	8.7	0.02	0.01	2.8	28	3
Monarto	Alfisol	7.9	0.04	0.03	1.0	< 0.2	8

Visualization technique

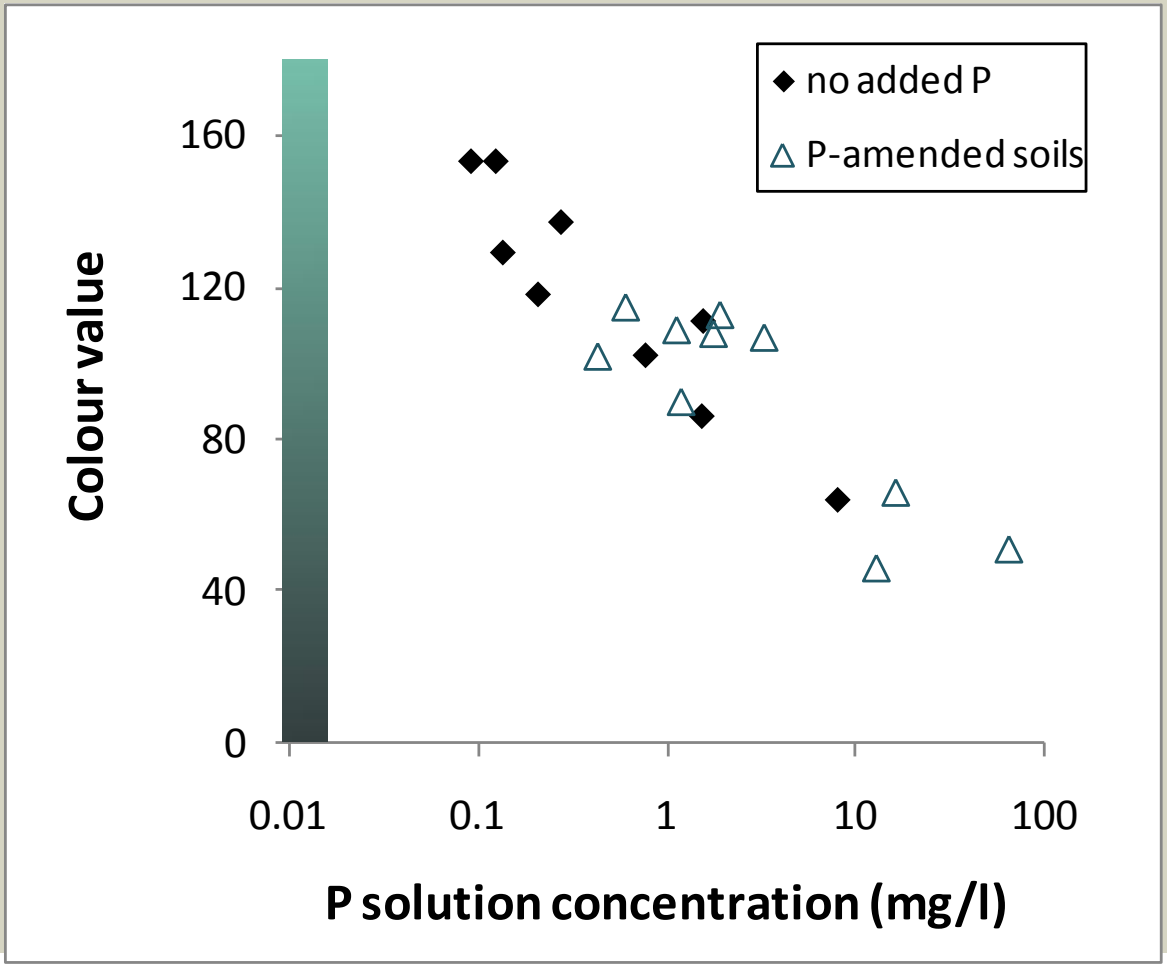
- Fe-oxide impregnated filter paper



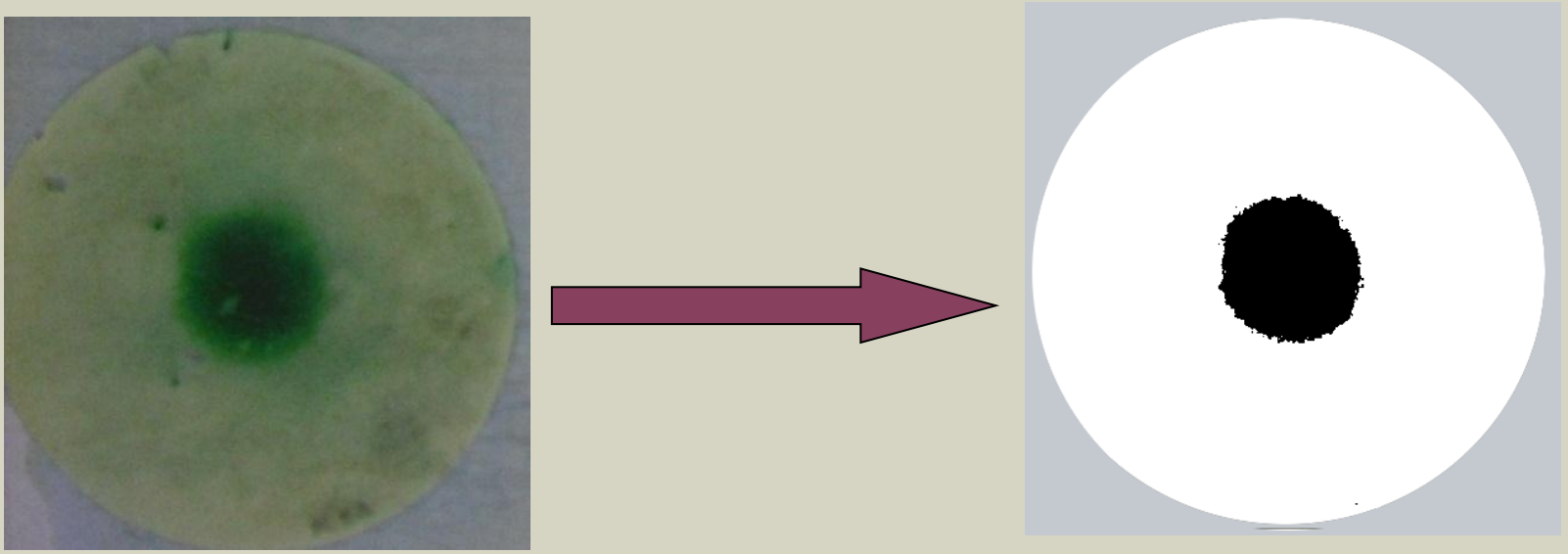
- Development of Fe-ox paper (Cutting & Roth, 1973)
  - 30 min in 1% ammonium-molybdate
  - 15 min in acid (1 N HNO_3) 1% amm.-molybdate + malachite green-oxalate solution (15 min)
  - 15 min in 5 N H_2SO_4

Calibration of technique

- Colour of paper ~ P solution concentration



Visualization of P diffusion

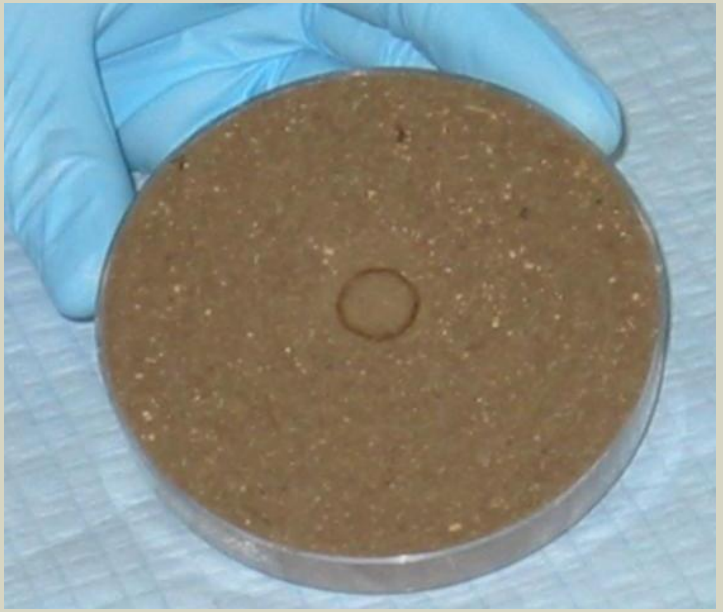


Green spots digitized using an imaging software GIMP v. 2.6.11

Exp. 1: Effect of P source on diffusion

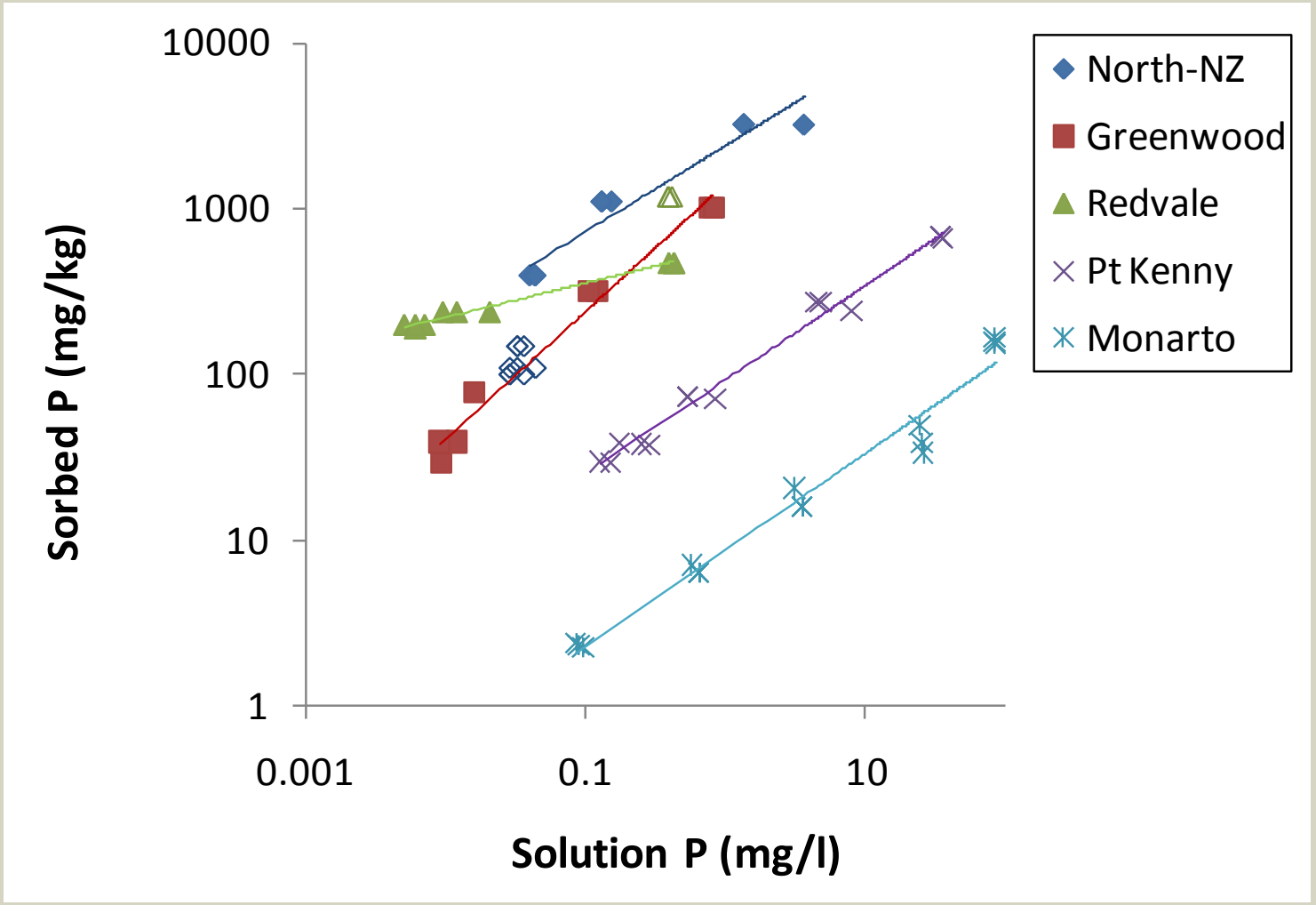
- 5 soils: 1 Andisol, 2 Oxisols, 1 Calcic Inceptisol, and 1 Alfisol

- Treatments (3 replicates):
  - Granular: SSP, TSP, MAP, DAP, MES10
  - Fluid: TG-MAP (200 µL), TG-MAP (100 µL), APP (44 µL)
  - All added at 9.2 mg P per Petri dish

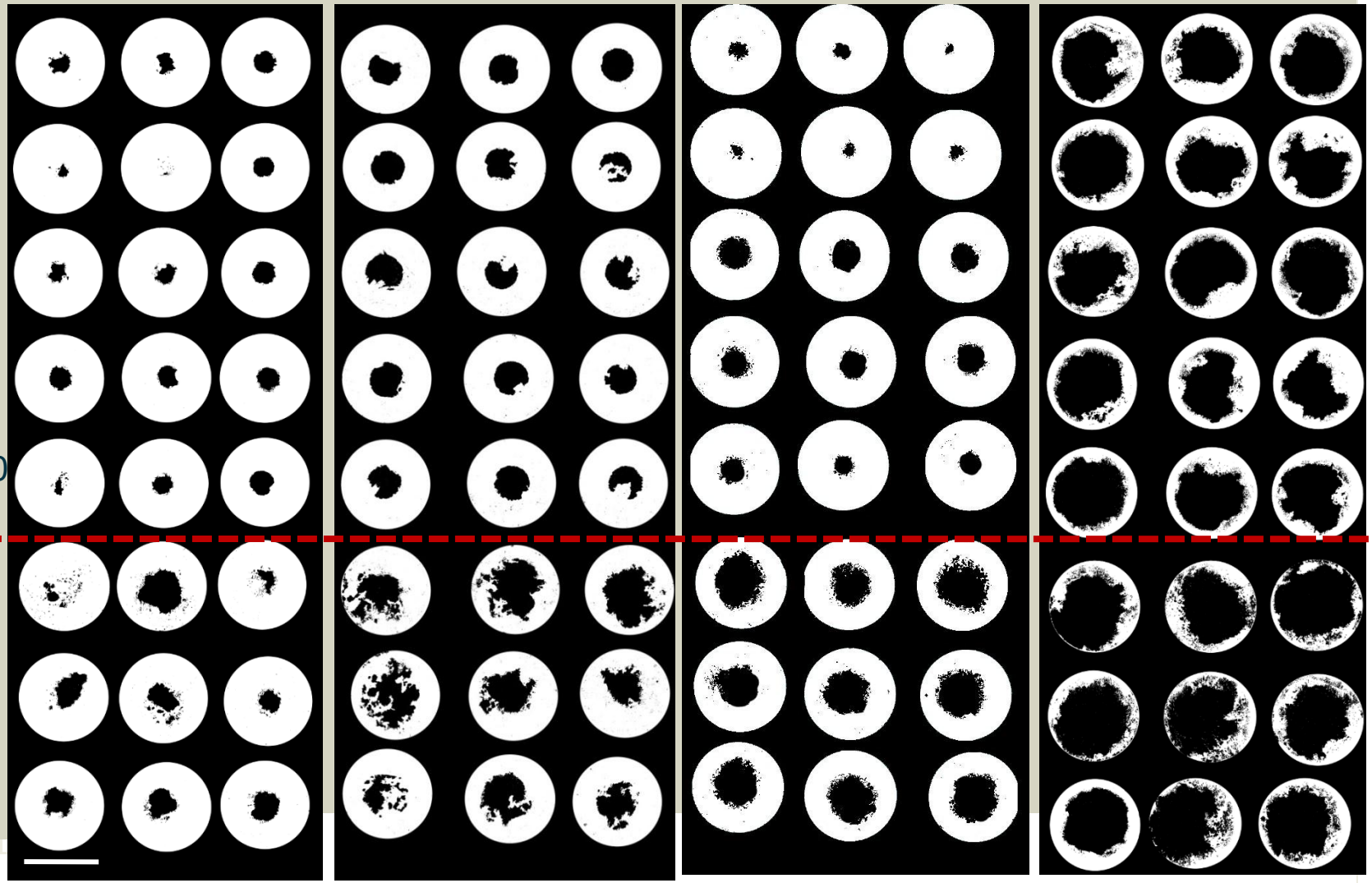


- Visualization at 7 and 35 d
- Granule removed and digested

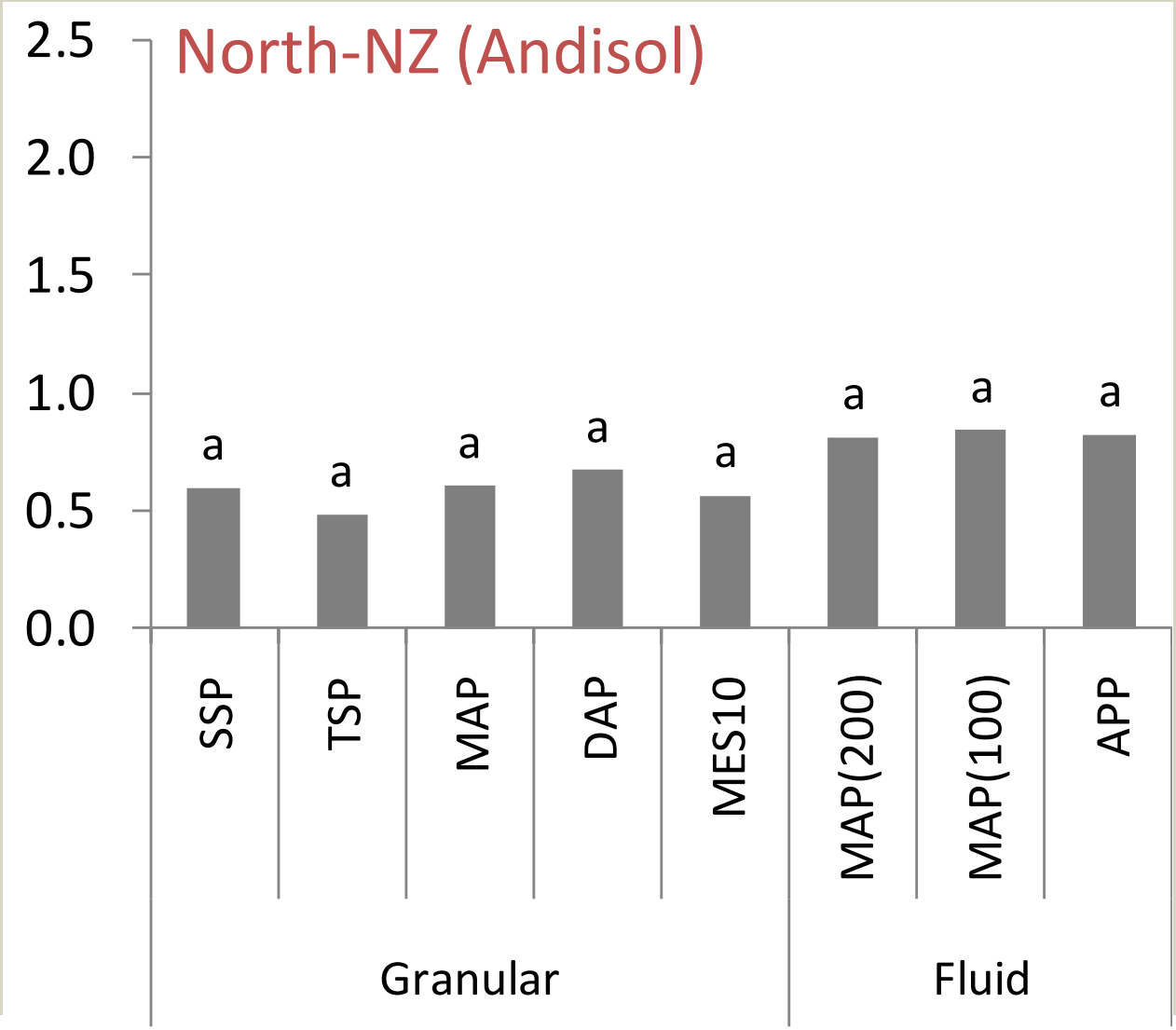
Exp. 1: P sorption isotherms



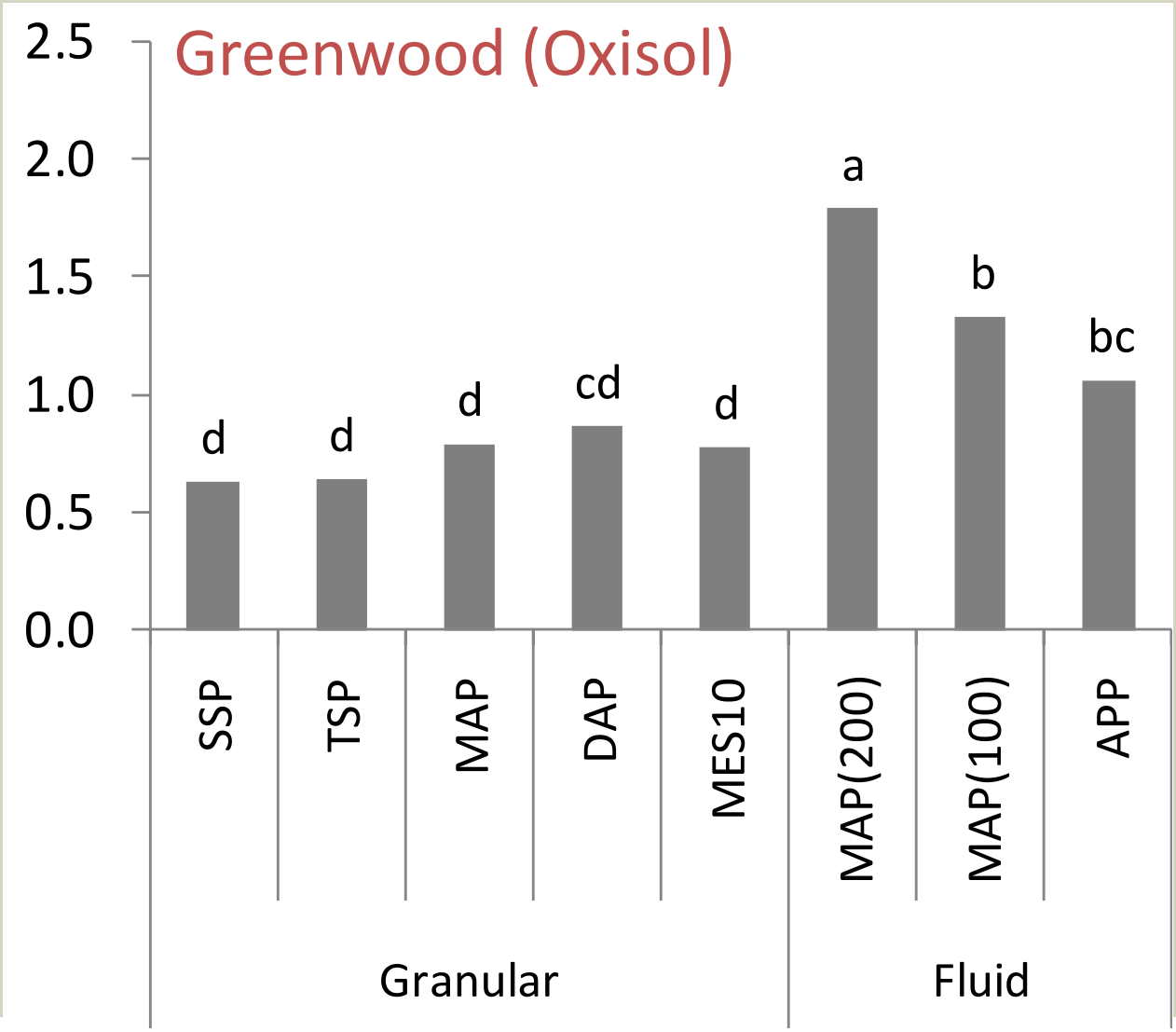
Source effect on P diffusion (day 7)



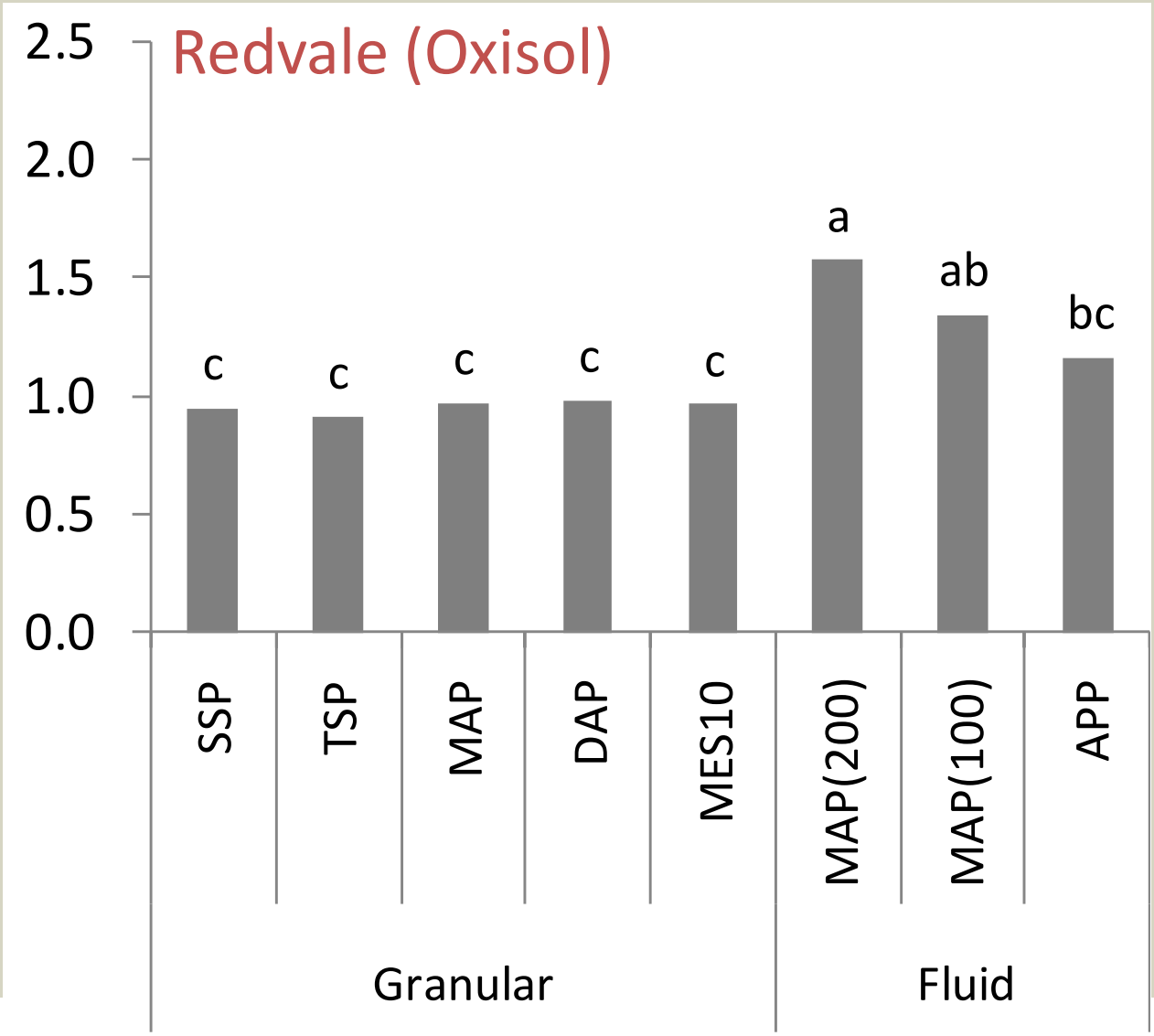
Diffusion radius (cm) @ day 7



Diffusion radius (cm) @ day 7



Diffusion radius (cm) @ day 7



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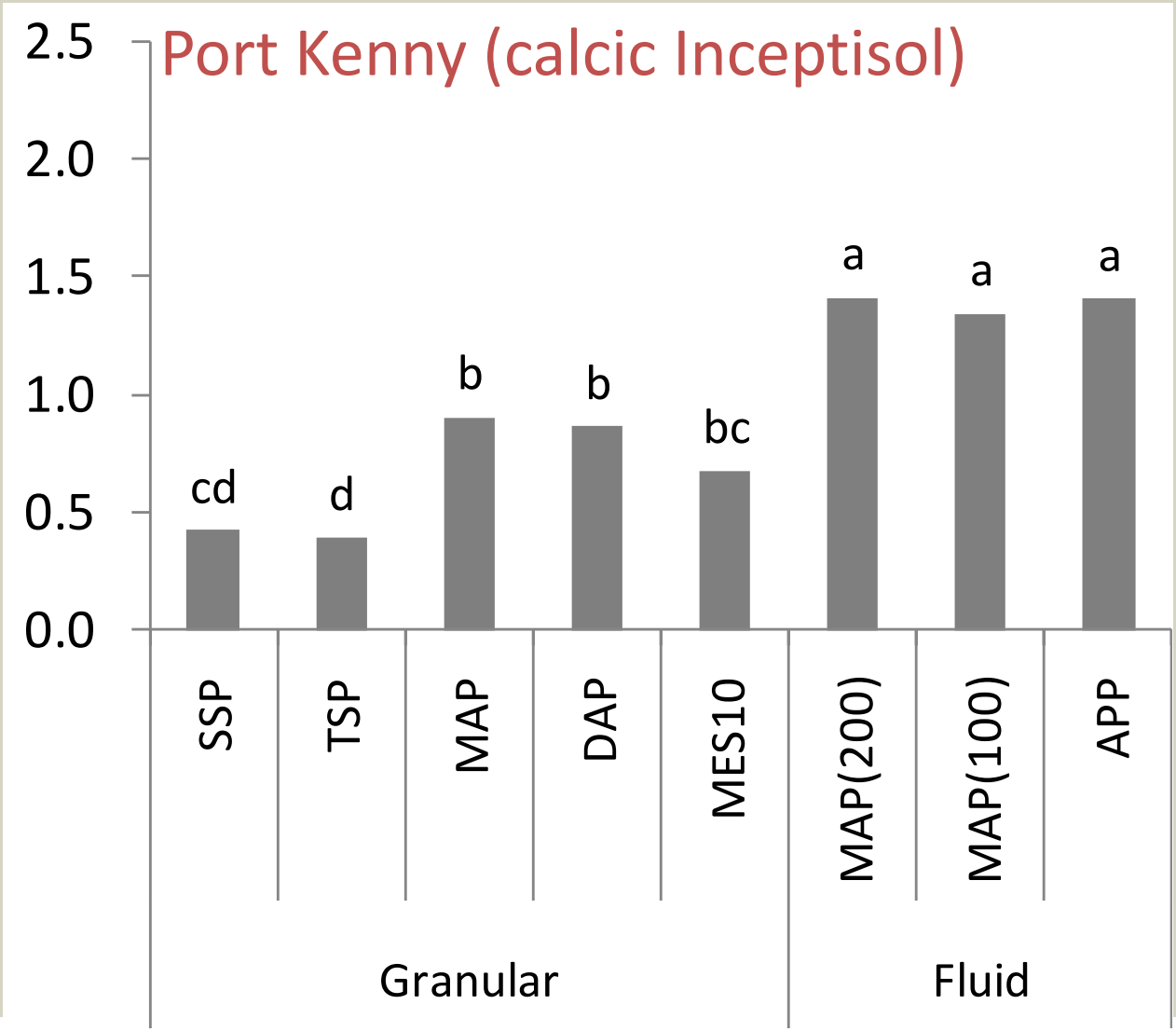

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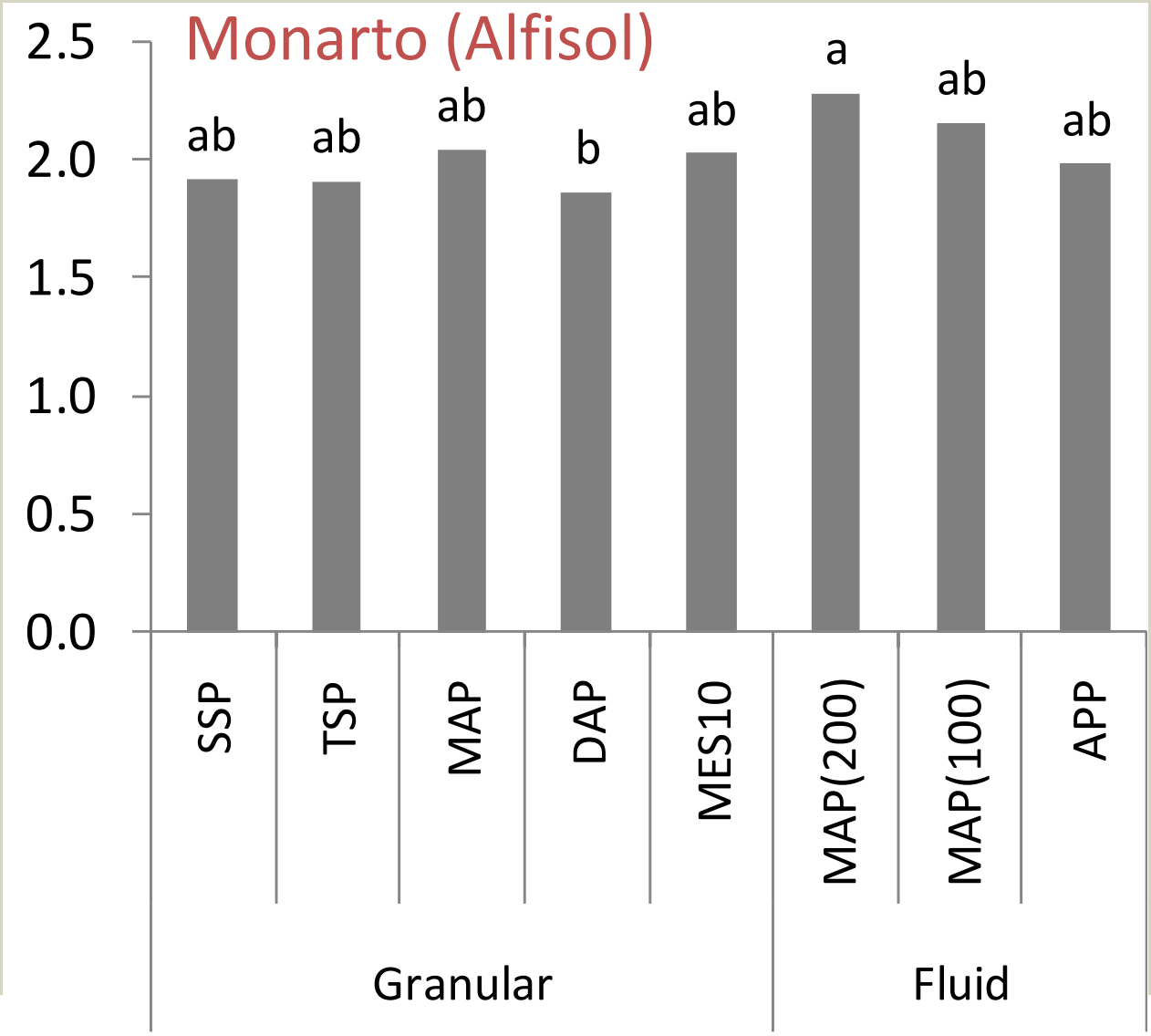
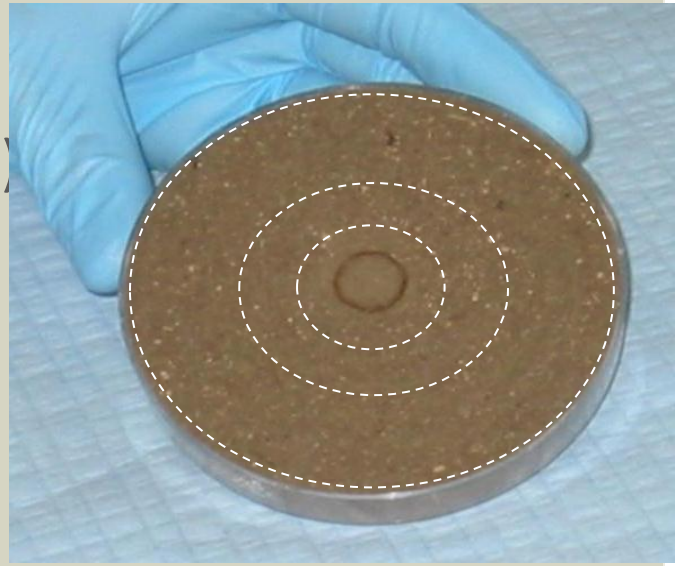


Exp 1: Summary

- There was a greater diffusion of P from fluid than granular sources in 3 of the soils
  - except in North-NZ (Andisol; strongest sorption) and Monarto (Alfisol; weakest sorption)
- There was lesser diffusion for Ca-phosphates (TSP, SSP) than ammonium phosphates (MAP, DAP) in the calcareous soil

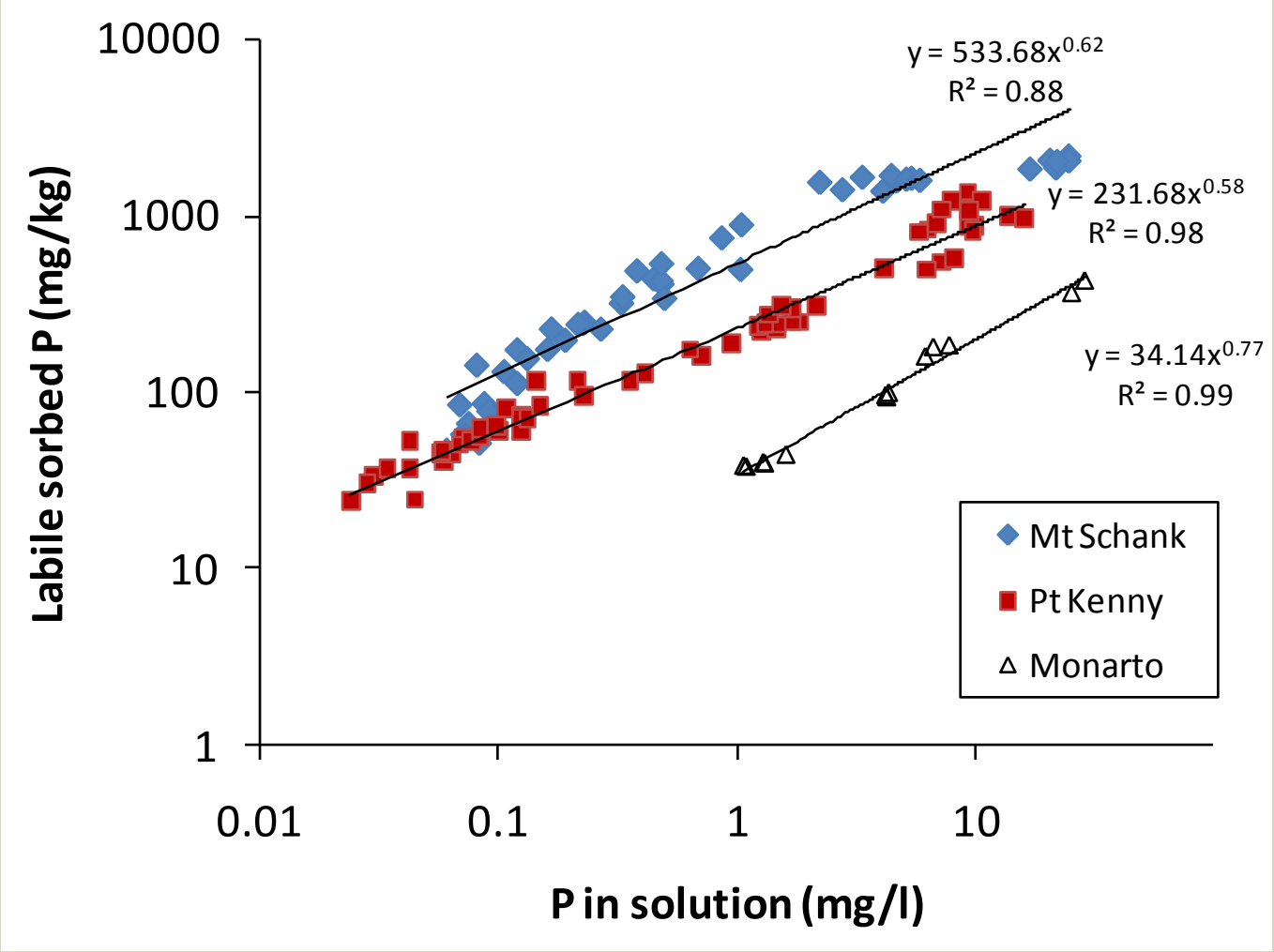
Exp. 2: Effect of source and moisture

- 3 soils: Andisol, calcic Inceptisol, and Alfisol
- Treatments:
  - 80% of θ_{sat} :
    - Granular: MAP, DAP, SSP
    - Fluid: TG-MAP (200 µl), APP (44 µL)
  - 55% of θ_{sat} :
    - Granular: MAP
    - Fluid: TG-MAP (200 µL)

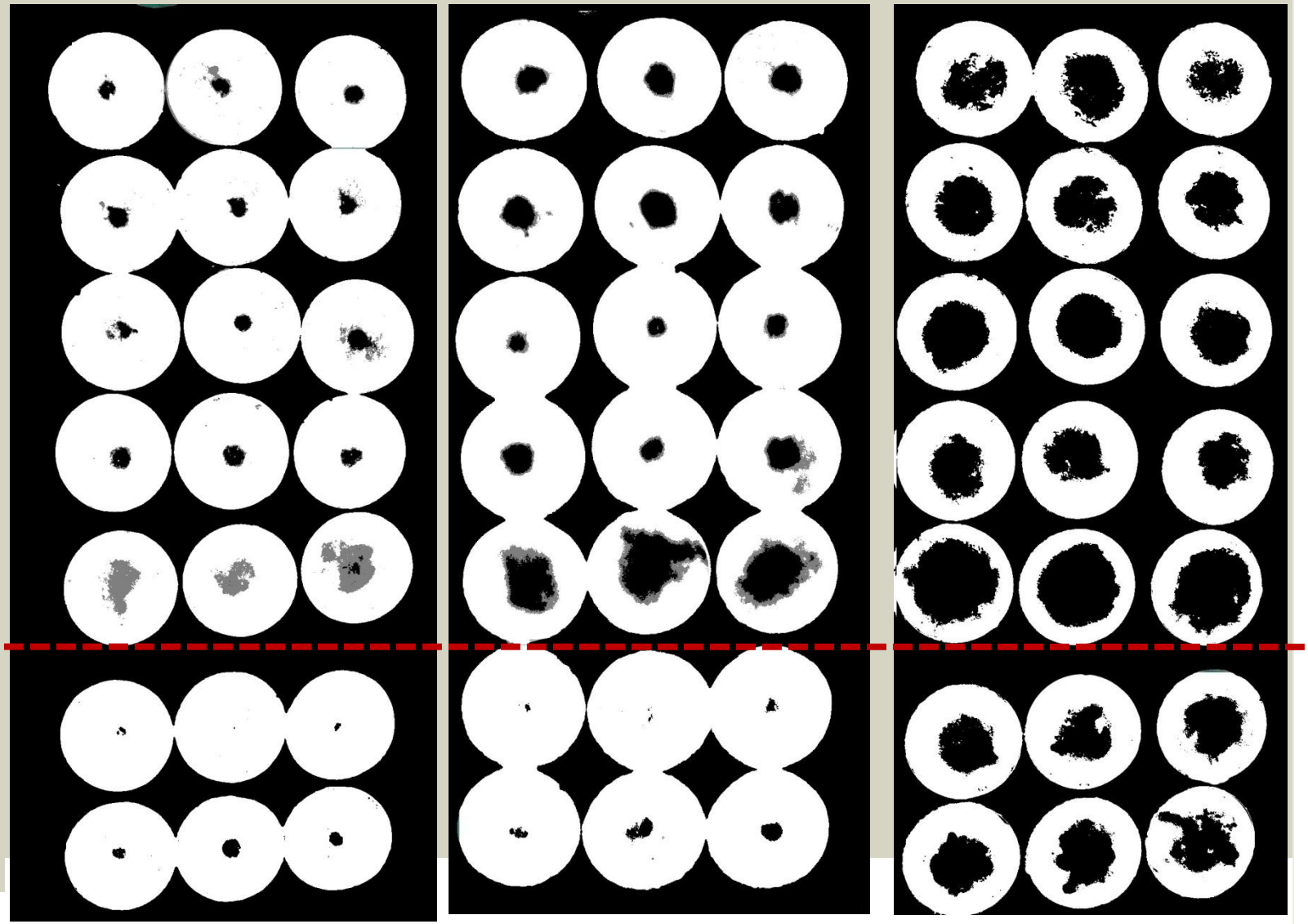


- Concentric sampling: total, labile and solution P

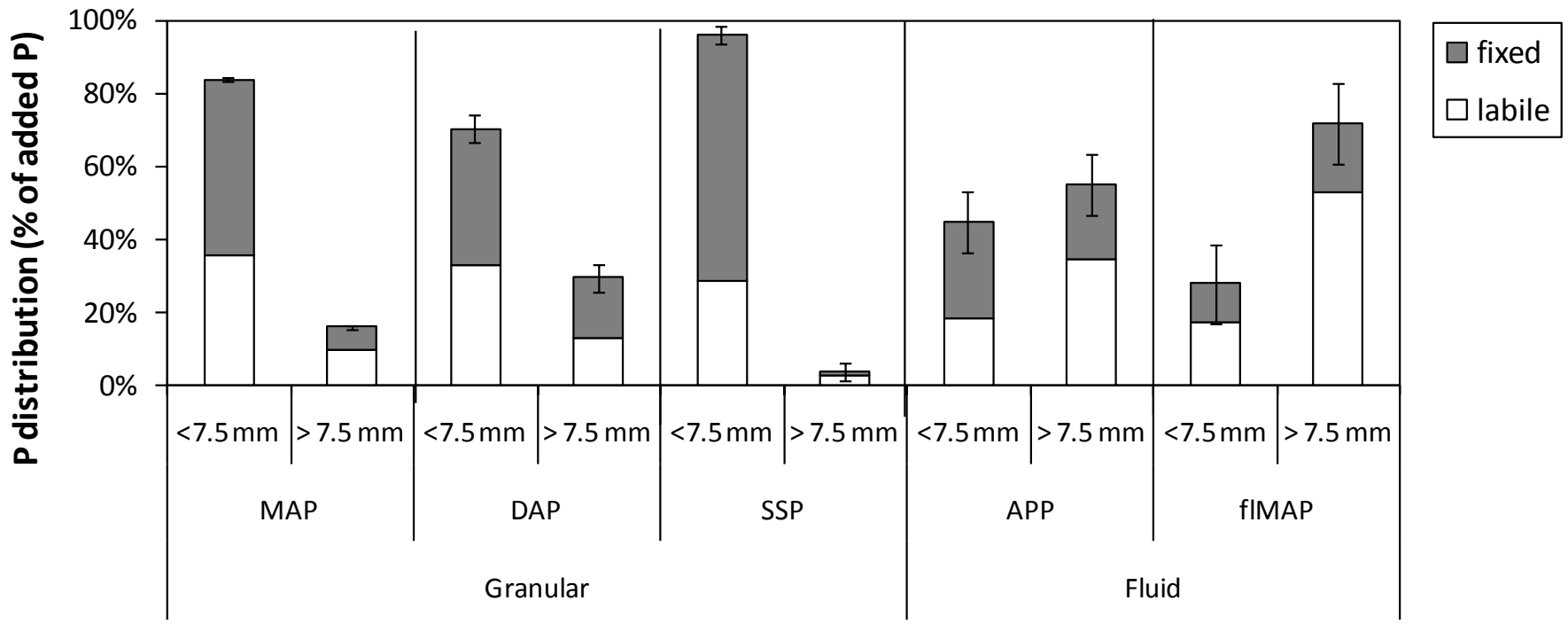
Exp. 2: P sorption isotherms



Exp. 2: Visualization (day 7)

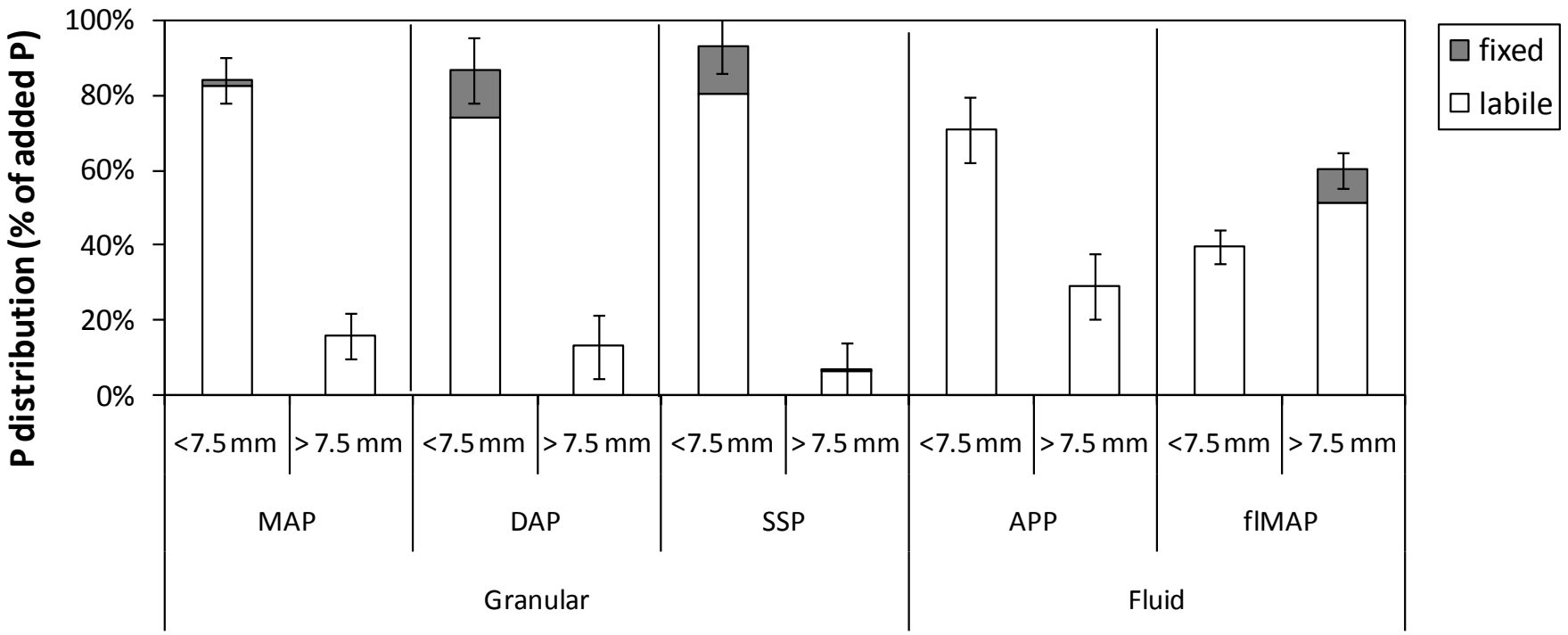


P source effect – (Calcareous)



- Fluid MAP > APP > DAP ≥ MAP > SSP
- Fixation (likely P precipitation with Ca):
  SSP > MAP ≥ DAP > APP > flMAP

P source effect – (Andisol)

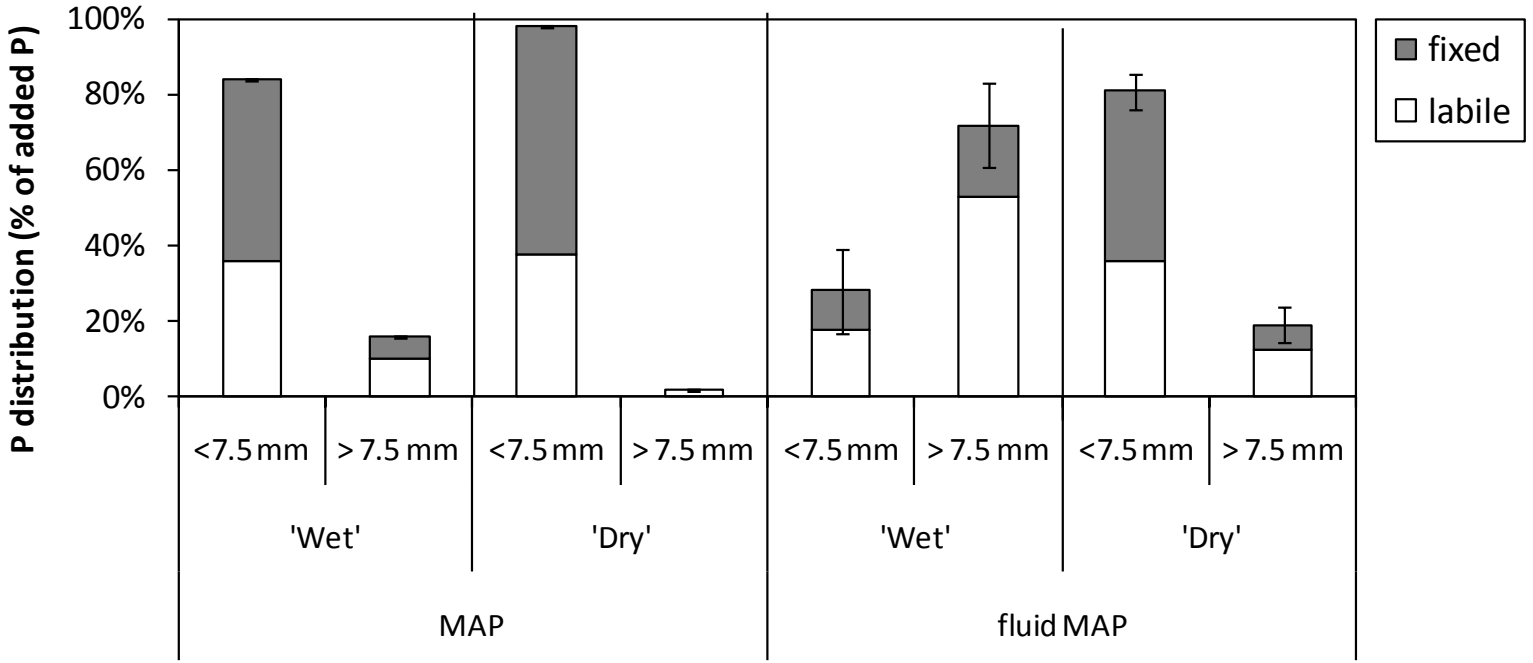


- Fluid MAP > APP > DAP ≈ MAP ≈ SSP
- Little fixation

Effect of moisture – (Calcareous)

	% added P fixed at <7.5 mm	
	MAP	Fluid MAP
Wet	44	7
Dry	57	41
Source	***	
Moisture	***	
Source x moisture	*	

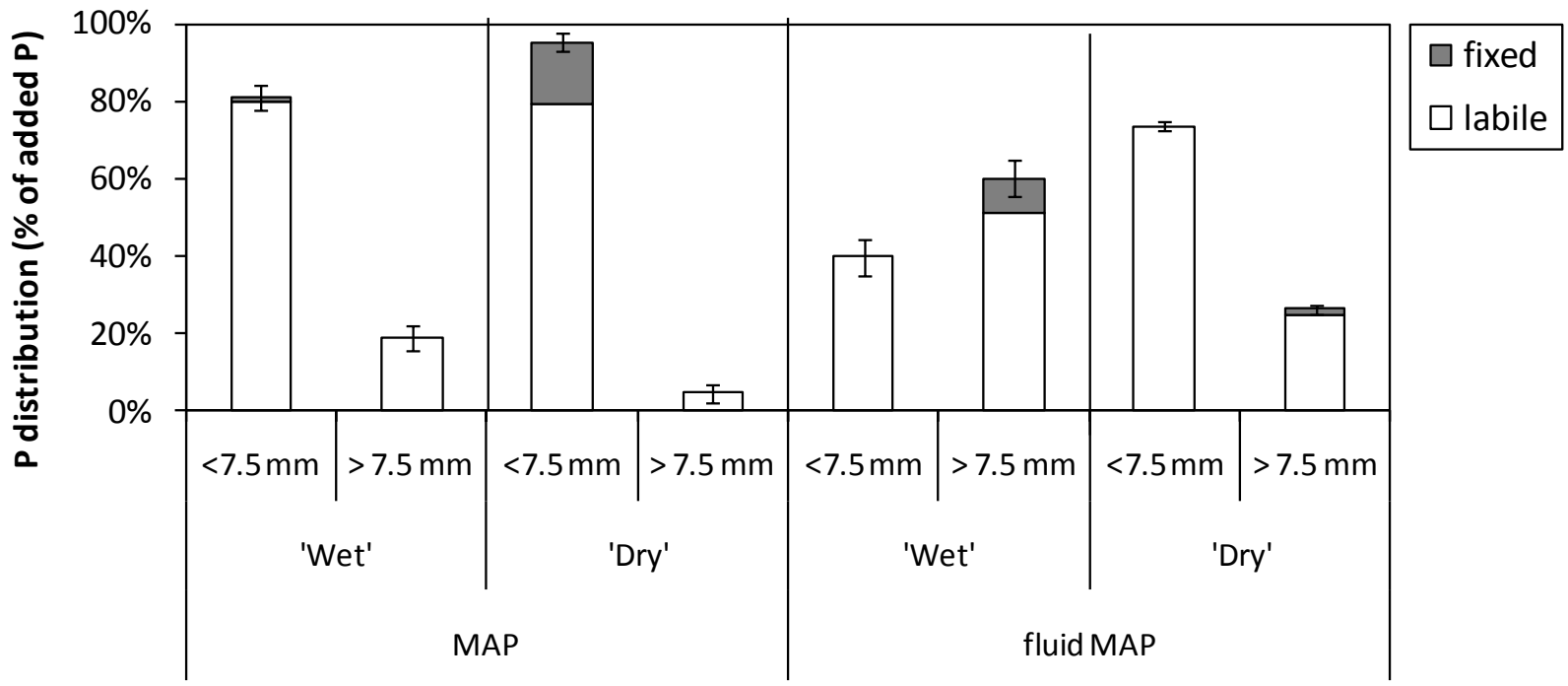
Less precipitation at high moisture content, especially with fluid MAP



Effect of moisture – (Andisol)

	% added P fixed at <7.5 mm	
	MAP	Fluid MAP
Wet	1	0
Dry	12	0
Source	ns	
Moisture	ns	
Source x moisture	ns	

Strong sorption but little precipitation in the Andisol;
no effect of moisture content or source on precipitation



Summary

- There was a reduced fixation of P in calcareous soil with fluid P, especially under wet soil conditions.
- There was more fixation of P in calcareous soil with SSP/TSP than with MAP/DAP (likely formation of Ca-P precipitates)
- Overall, there was a greater diffusion of P from fluid P than from granular P in most soils.

Conclusion

- Less precipitation is likely to enhance fertilizer efficiency, esp. in wet calcareous soils
- Enhanced diffusion of P from liquid P in soils with strong sorption but little precipitation may have agronomical benefits. Further work will be carried out.

Acknowledgments

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Thanks for your attention

Ca enhances fixation

- There is less diffusion and more fixation for SSP than MAP in the Kingaroy soil: