EFFECT OF SOIL WATER ON PHOSPHORUS USE IN AGRICULTURAL SOILS

THE UNIVERSITY OF ADELAIDE
AUSTRALIA



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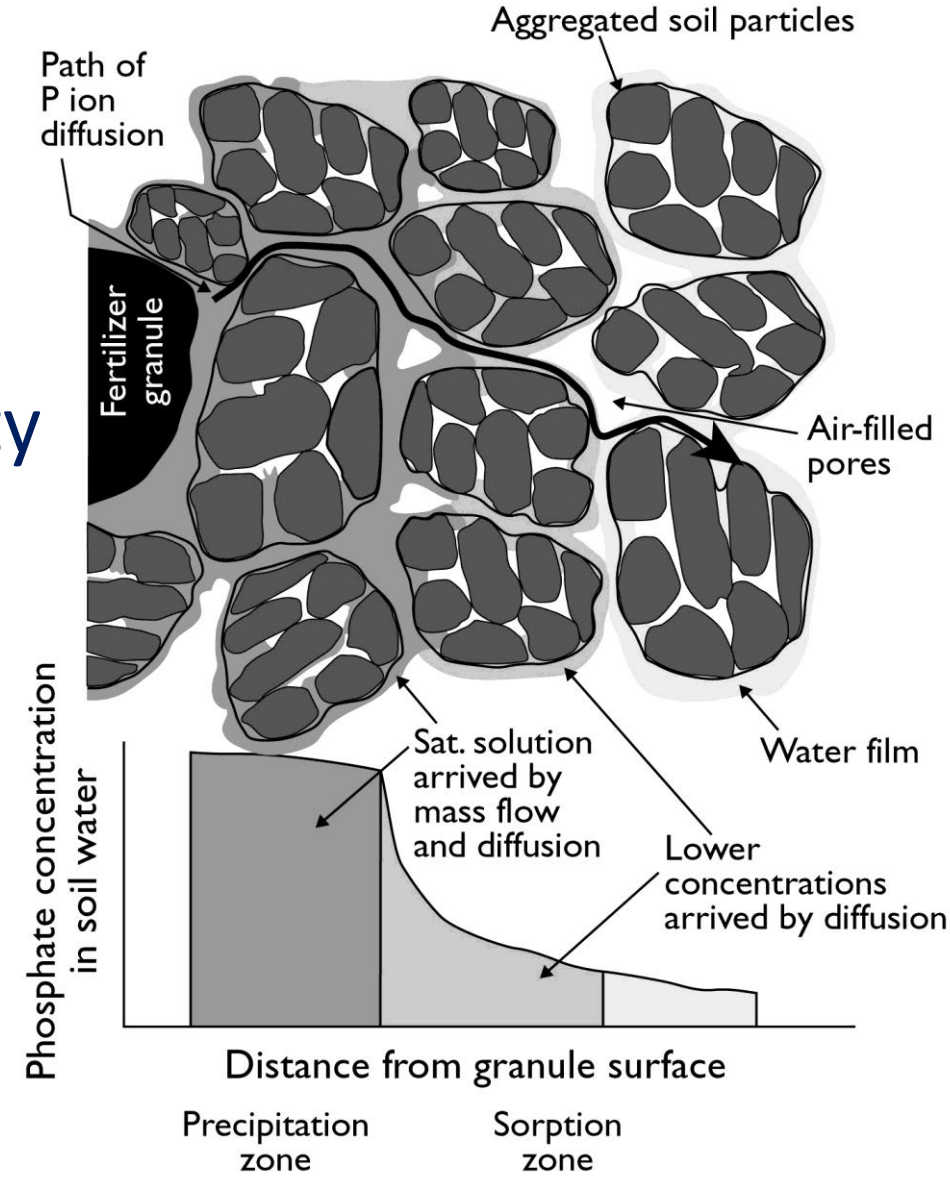
Research Questions

- What is the effect of dry sowing on fluid and granular P fertilizer diffusion and availability?

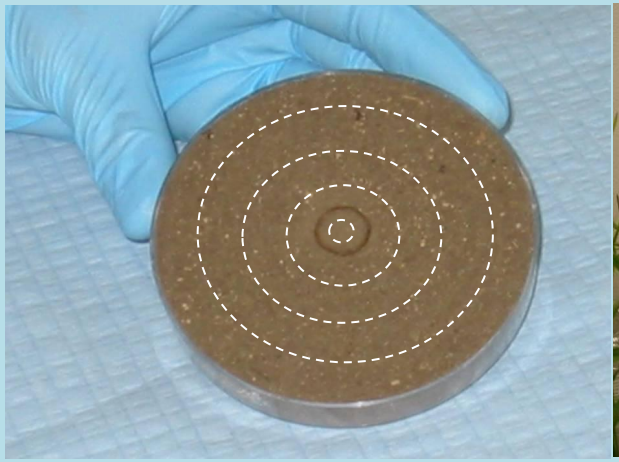
- How does soil moisture affect P extraction from the topsoil and subsoil?

Fate of Fertilizer P

- Precipitation
- Adsorption
- Physical Inaccessibility
- Erosion and leaching
- Crop uptake



Hedley and McLaughlin, 2005



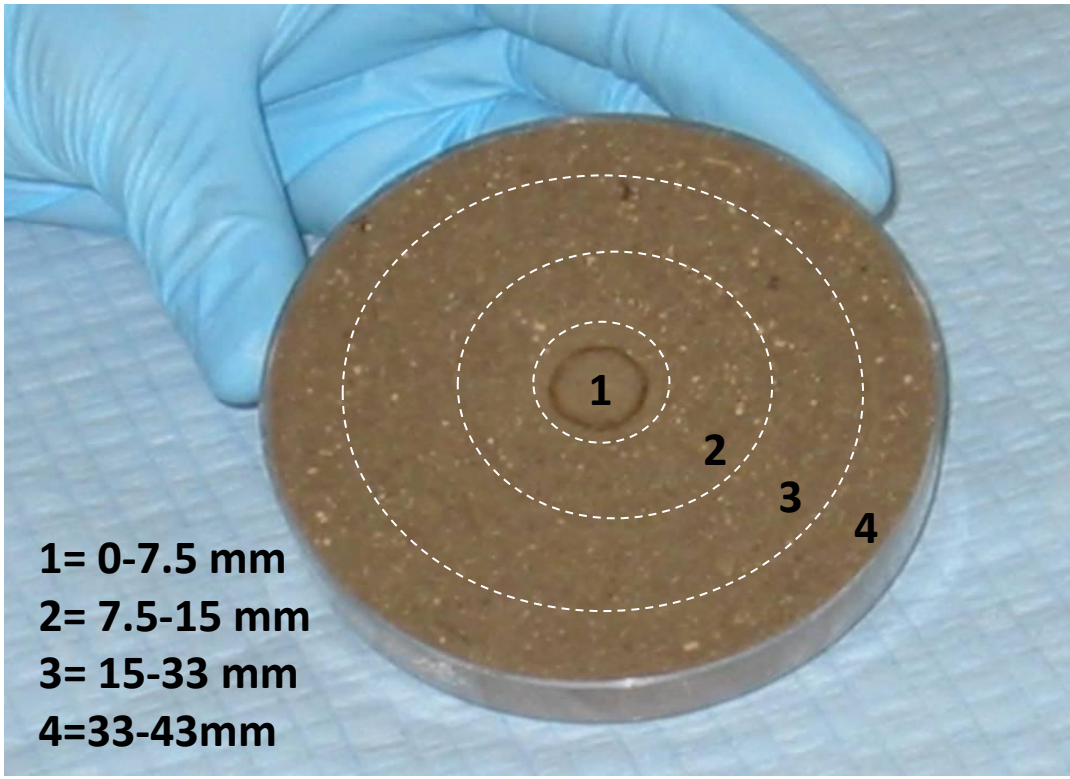
Laboratory work: P diffusion, sorption and fixation measurements

Glasshouse Controlled Environment Plant Responses to Moisture x Nutrient Treatments

Field P uptake from top & sub-soil Moisture x Nutrient Treatments (irrigated for comparisons)

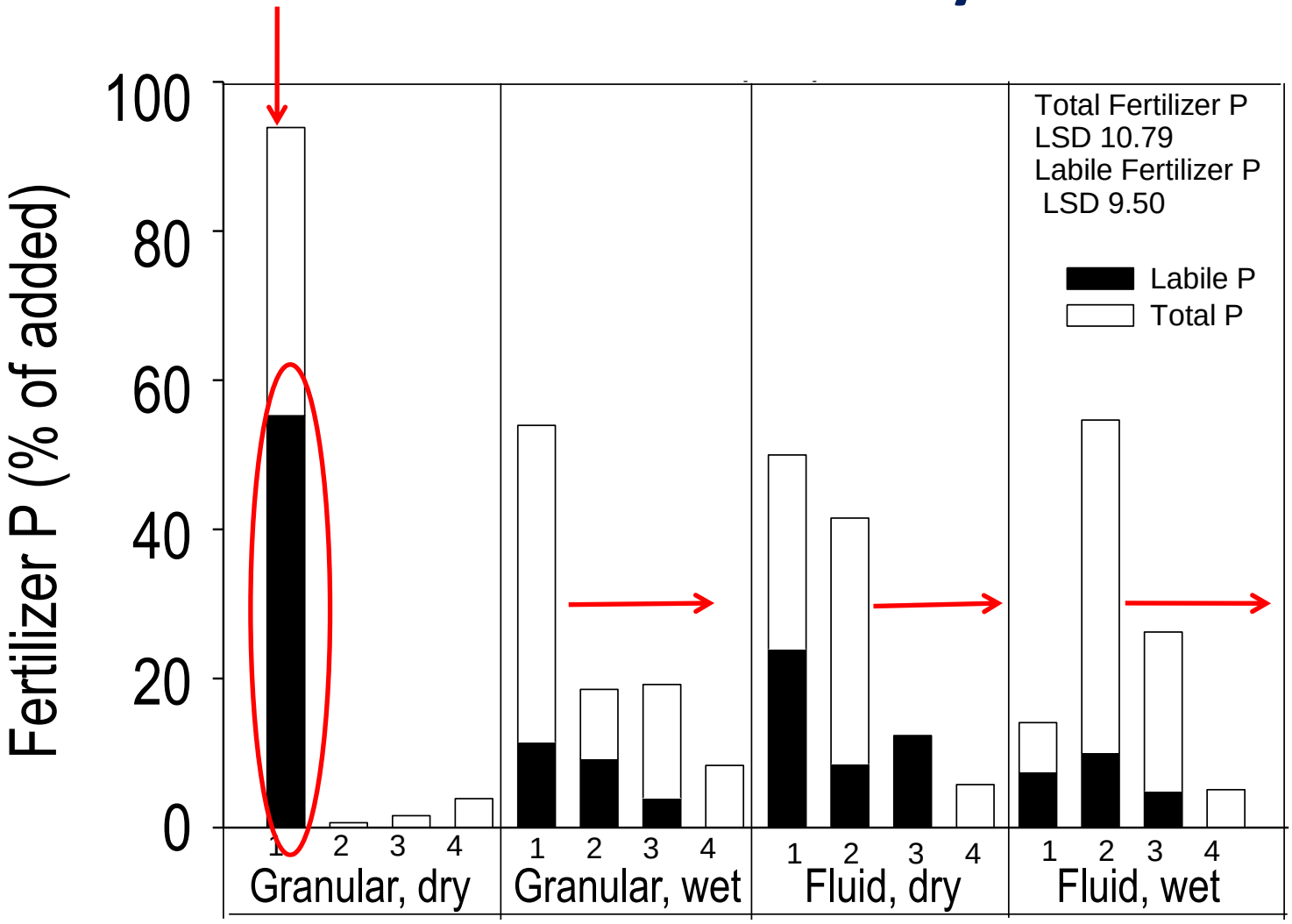
Experimental Design

6 soils
2 ferts (fluid and granular)
2 moistures
(air dry / 80% field capacity)
3 reps
Sampled in 4 sections



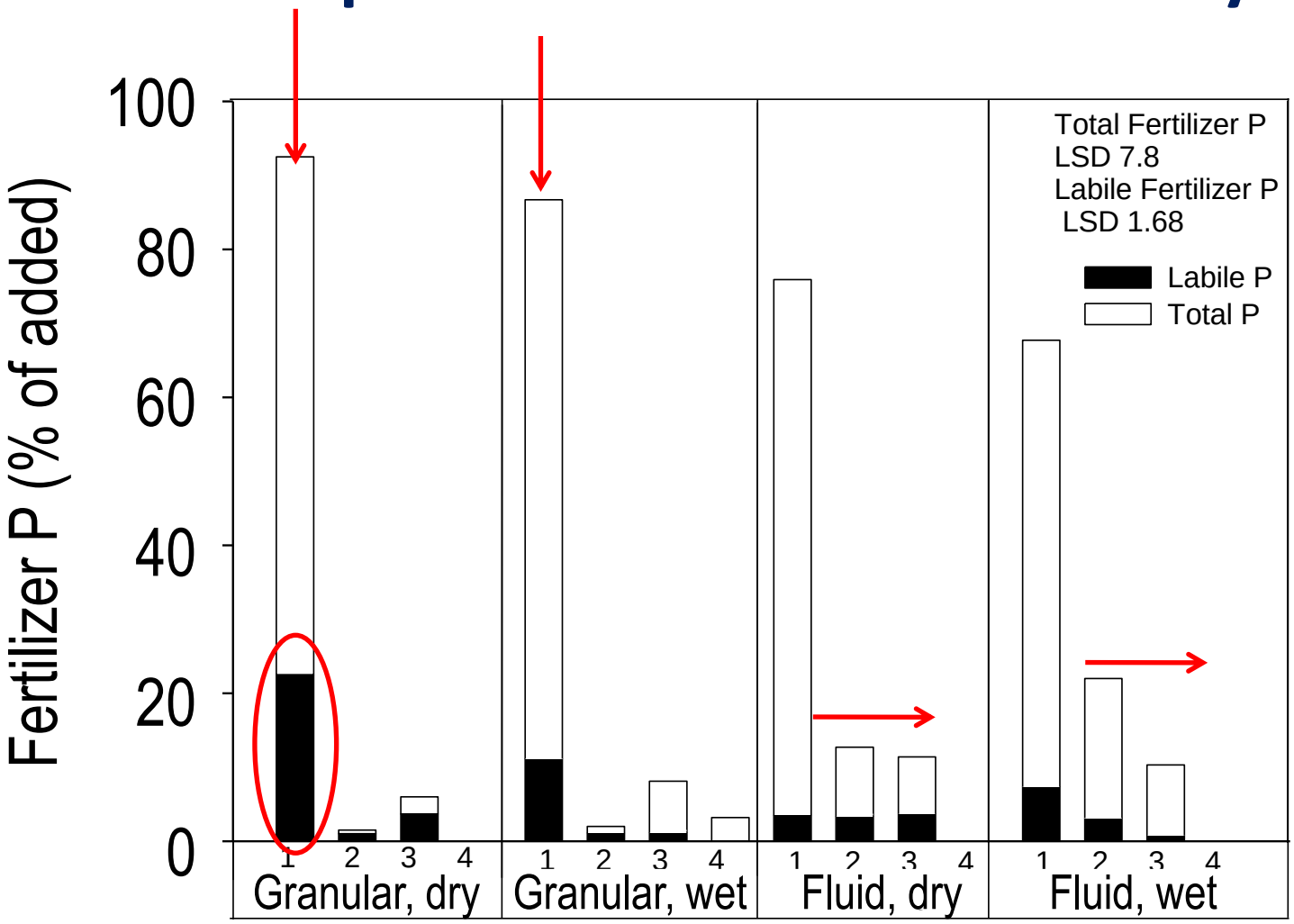
- Total P
- Soil Labile P
- Plant response
  (growth and fertilizer uptake after incubation)

Diffusion and Lability of P



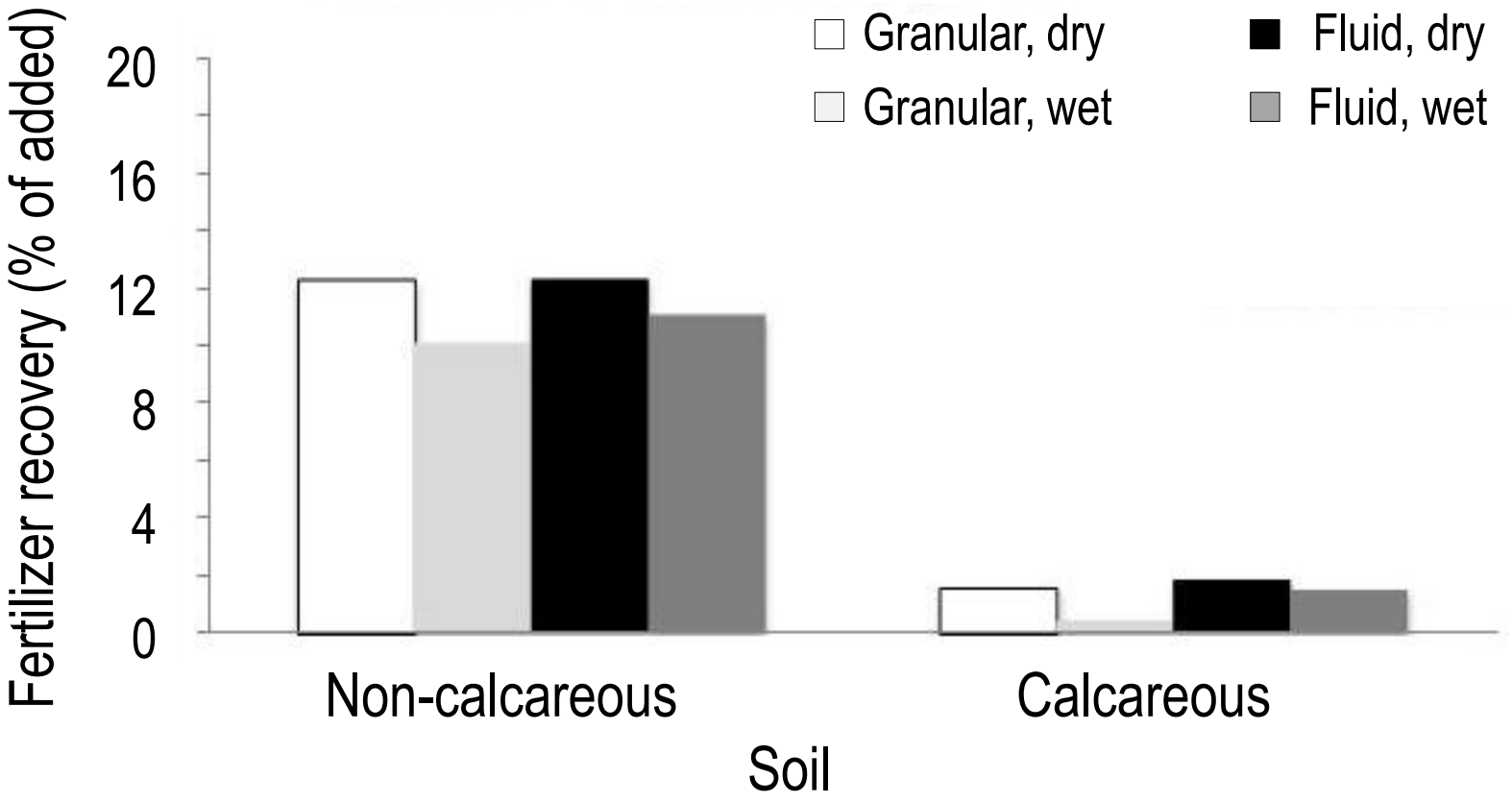
Low soil test P, non-calcareous (<1% $CaCO_3$), $pH_{(water)}$ 7.6

Phosphorus Diffusion and Lability



Low soil test P, 75% $CaCO_3$, alkaline $pH_{(water)}$ 8.3

Subsequent Plant Fertilizer Uptake



- Plants absorbed same P regardless of whether it was applied to dry or wet soil or as granular or fluid P

Key Findings for P Management

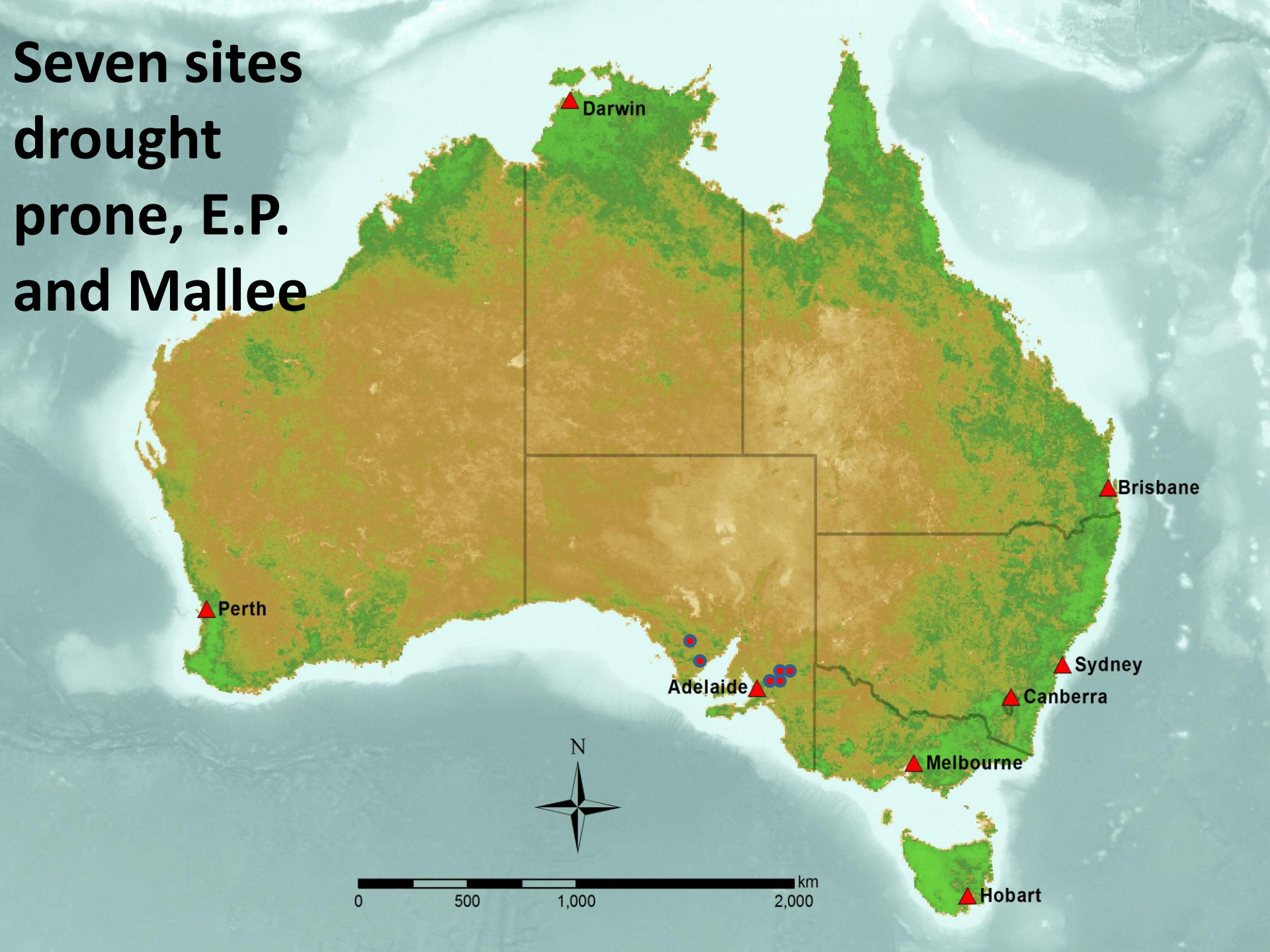
- Dry sowing restricts diffusion of fertilizer but did not decrease plant uptake of fertilizer.
- But what happens in the field where plants take up P from both the topsoil and subsoil?

Understand the ability of crops to access P in drought.

Research questions:

- How much fertilizer P is taken up by wheat in dry vs. wet conditions?
- Does fertiliser application and soil moisture affect P uptake from topsoil and subsoil?

Seven sites drought prone, E.P. and Mallee



Design

Nutrients

- +/- fluid P (phosphoric acid at 15 kg P/ha; 34 kg P_2O_5/ha)
- N and Zn for all treatments

Sites

- 7 sites with 3 for topsoil/subsoil measurements.
- 2 sites discussed today

Water

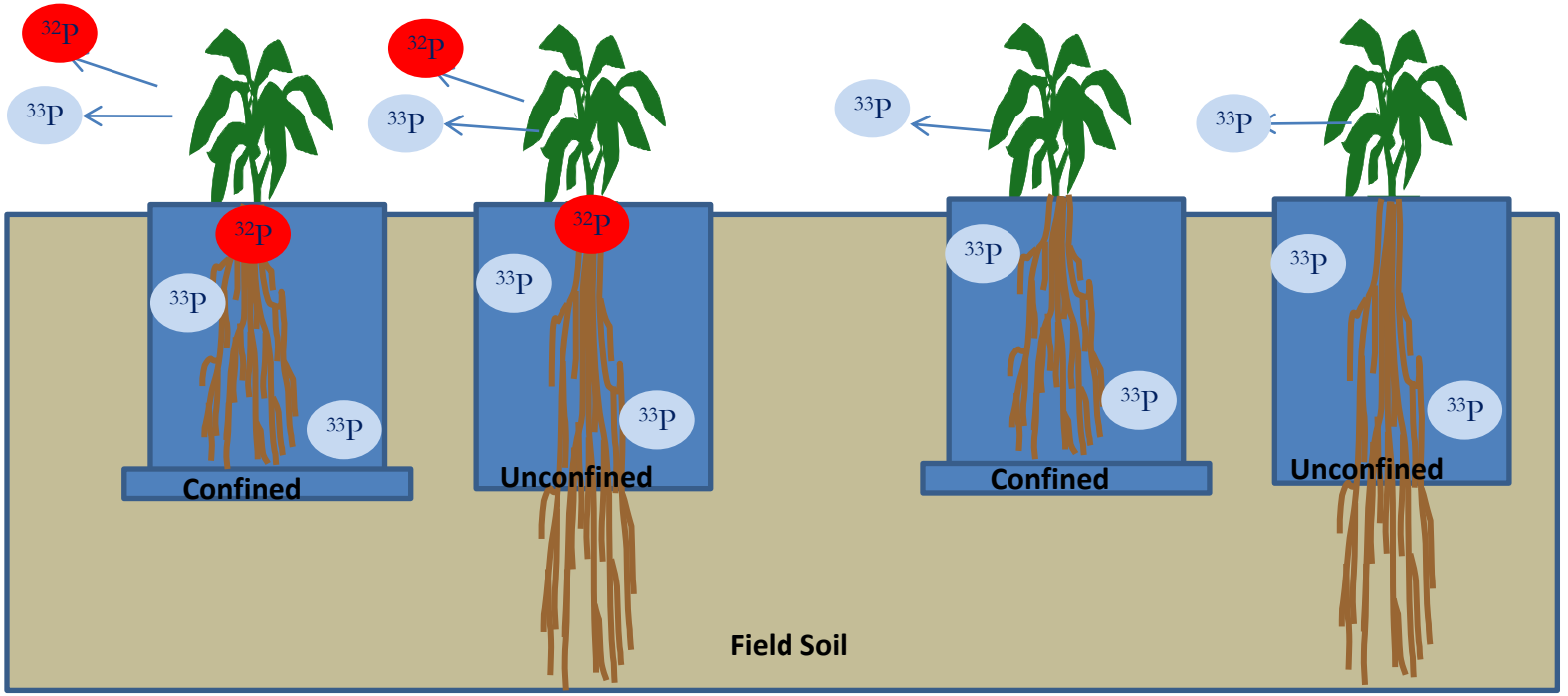
- Watering 1 x per week at decile 3 and decile 8 rainfall, some modification required due to wet start, cool season and subsoil moisture.

P from fluid fertilizer= plant ^{32}P /fluid fertilizer added ^{32}P

P from subsoil= 1- (^{33}P per mg P uptake unconfined / ^{33}P per mg P uptake confined).

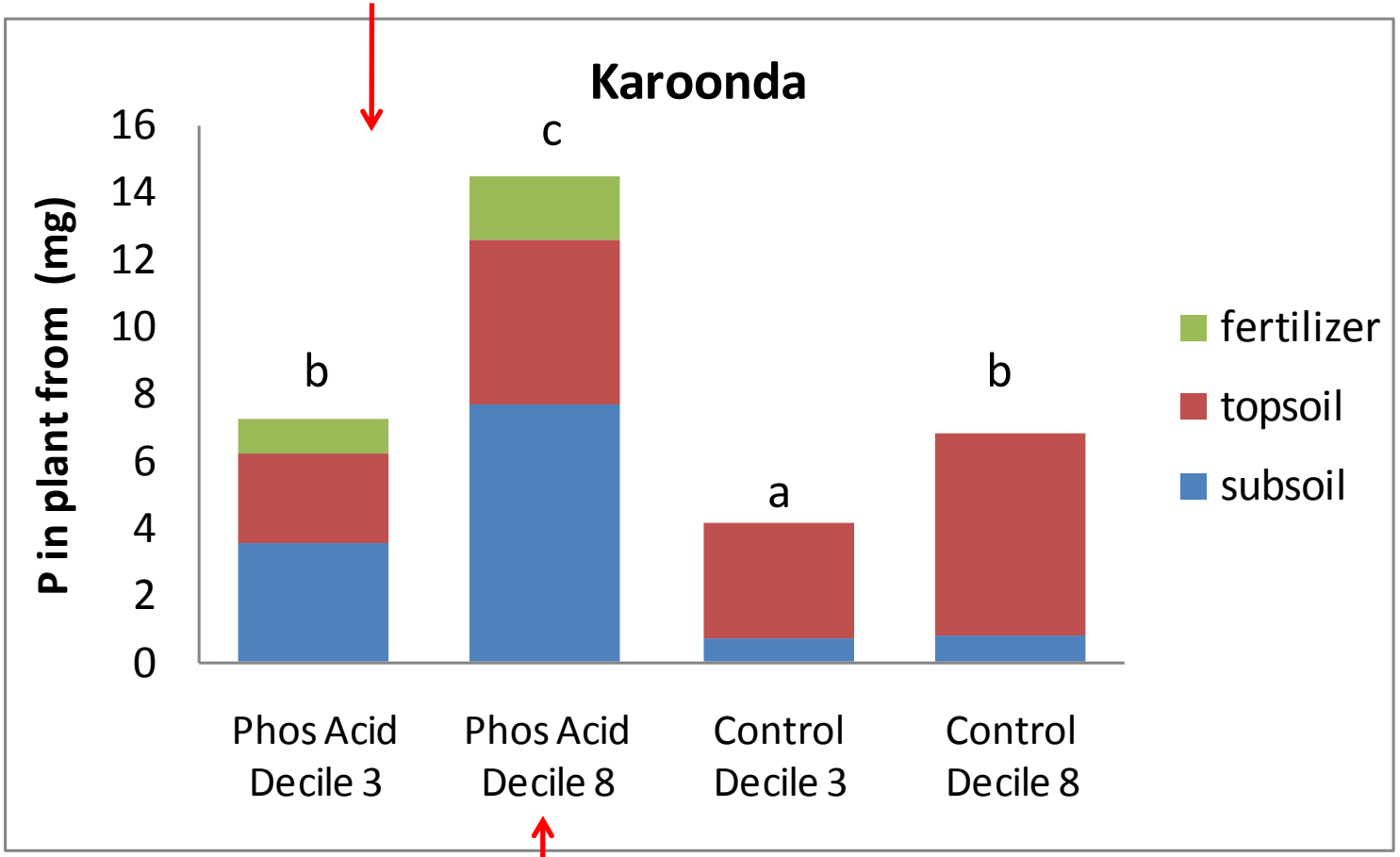
P topsoil= total P uptake- P from subsoil

* If confined roots do not mobilise sparingly soluble P this will work (being checked).



Karoonda (Deep Sand)- Plant use of Fluid Fertilizer, Topsoil and Subsoil P

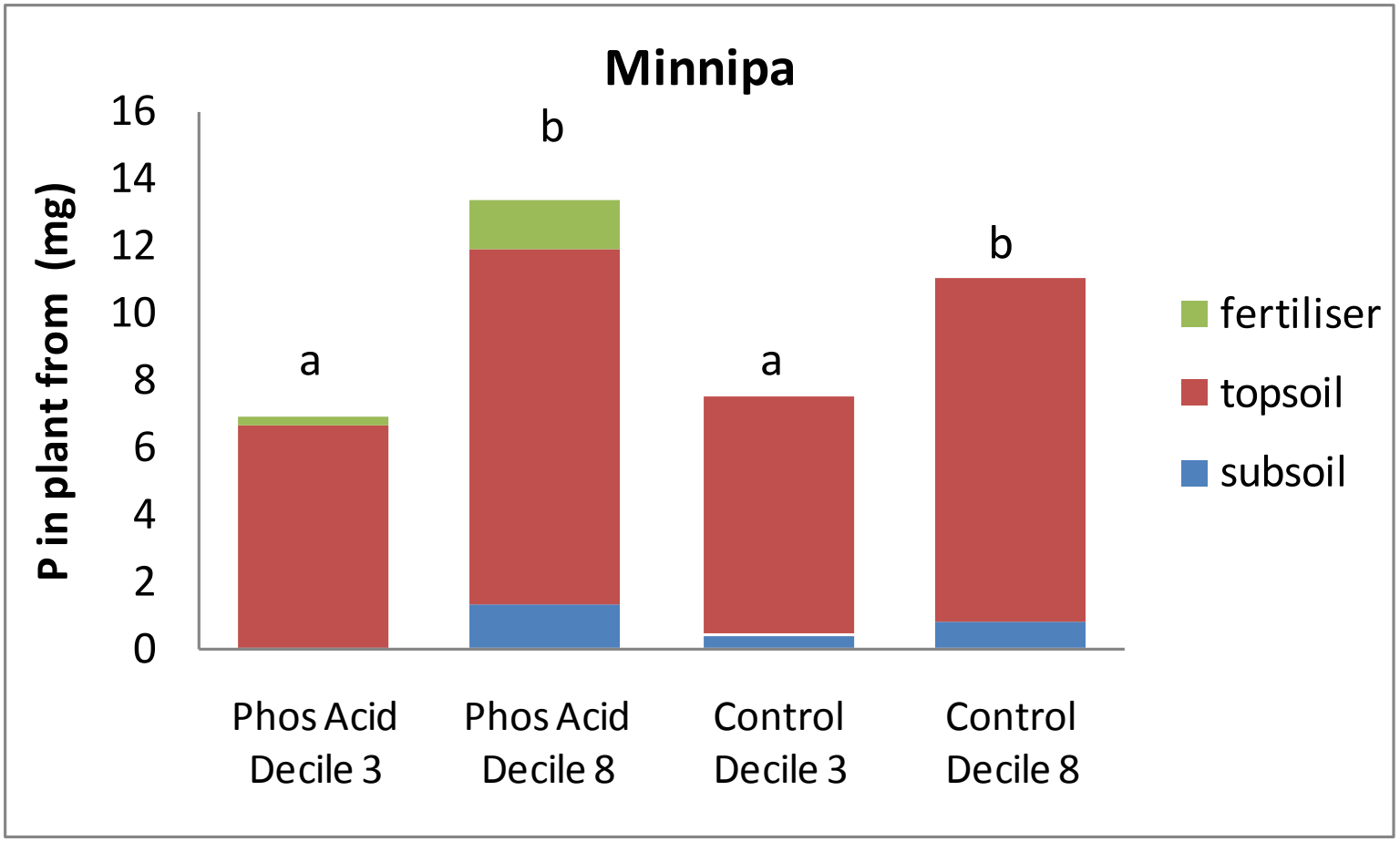
More subsoil extraction when fertilized



Fertilizer Extraction > when wet

Fertilizer recovery = 9.2 % decile 3, 16.3 % Decile 8

Minnipa- Plant use of Fluid Fertilizer, Topsoil and Subsoil P



Fertilizer Extraction > when wet (3.18 % decile 3, 12.61% Decile 8)
Wet treatment allowed some subsoil access in a subsoil with very high pH, boron and sodicity.

Key Findings for P management

- Fluid fertilizer efficiency in year applied is between 3 and 30% of added = 0.5-4.5 kg P/ha

  At 10-20 kg P/ha this would easily replace the fertilizer used directly

- 70-97% of crop P uptake was derived from the soil, which highlights the importance of maintaining fertility and regular soil testing
- Subsoil P was better utilised when topsoil fertilized
- Subsoil constraints will interfere with utilisation of subsoil P

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