Engineered Carbon-Clay Composite-Based Novel Fertilisers to Overcome Nutrient Stratification in Soil

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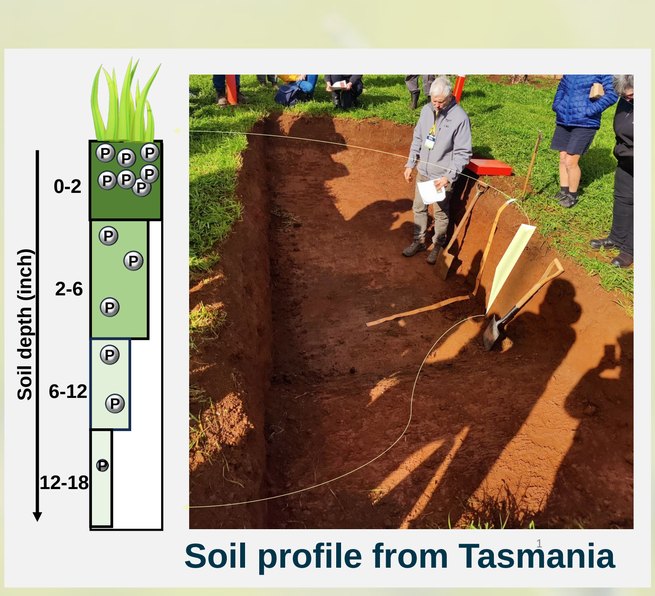
1. Overview

Phosphorus (P) stratification: An oversupply of P in the surface soil and an undersupply of P in soil deeper than 6 inches

P is typically applied as a **fertiliser** to the soil surface

P content (0-5 cm; 35 mg P/kg soil); (10-30 cm; <5 mg P/kg soil)



Soil profile from Tasmania

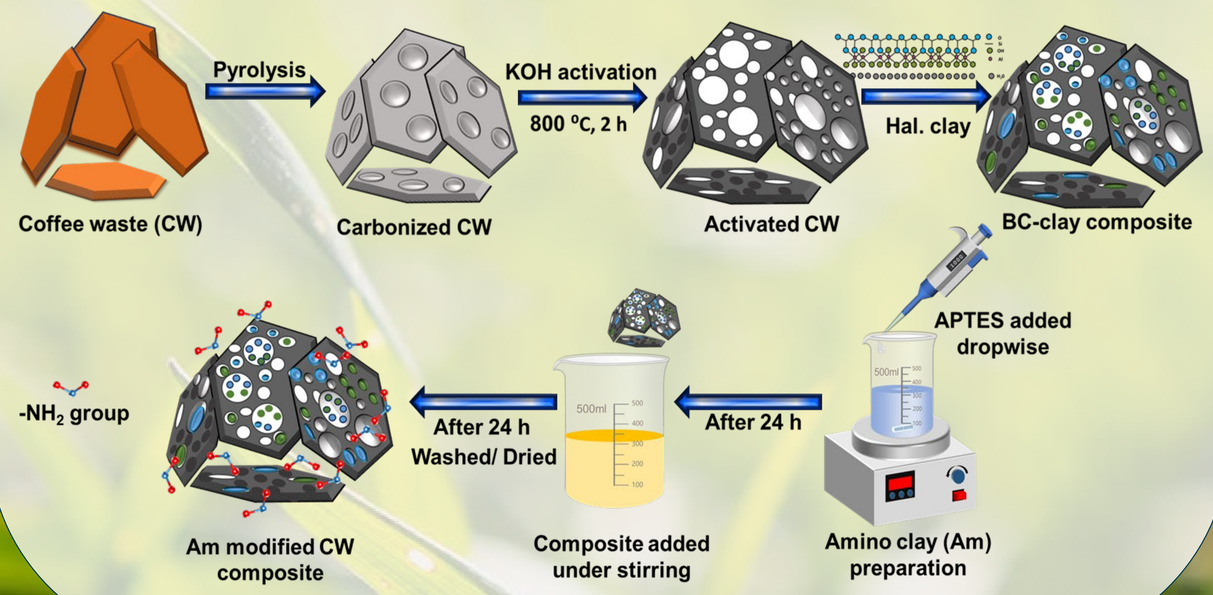
Agricultural soils in Australia often face issues with P deficiency

→ Need to apply **P fertilisers** to the soil to achieve **productive yields**

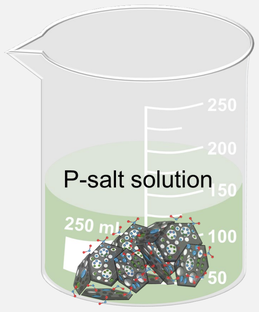
2. Approach

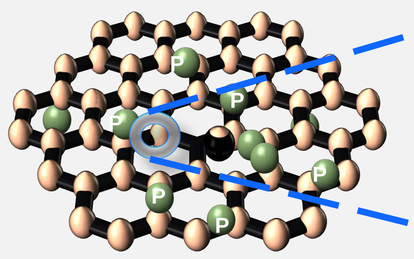
Biochar (BC) has a **porous structure** and unique properties that make it an effective carrier for delivering various nutrients in soil

Amino clays enhance **BCs** ability to adsorb more **P** through **electrostatic attraction** and **re-precipitation** in its pores and prolong the period of P release

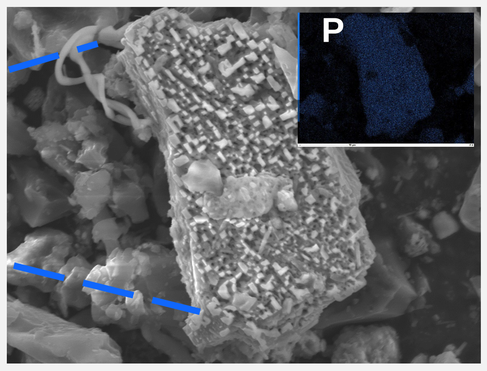


3. Preliminary Results

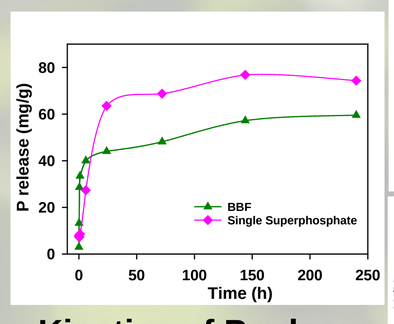




Synthesised fertilizer (BBF)



P release in DI water: **0.2 g** of **BBF and** commercial fertiliser **single superphosphate** (for comparison) soaked in **200 ml DI water**

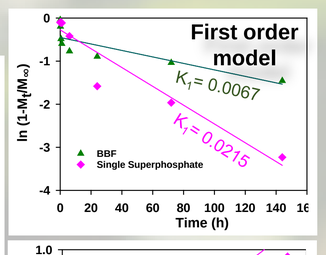


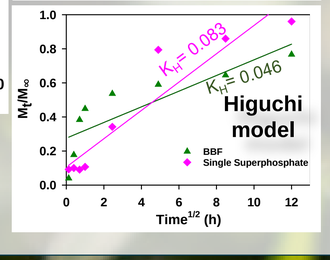
Kinetics of P release

Release data of **P** Vs **time** fitted to the **first-order** model and the **Higuchi** model

$$\ln(1-\frac{M_t}{M_\infty}) = -K_1 t$$

$$\frac{M_t}{M_\infty} = K_H t^{1/2}$$



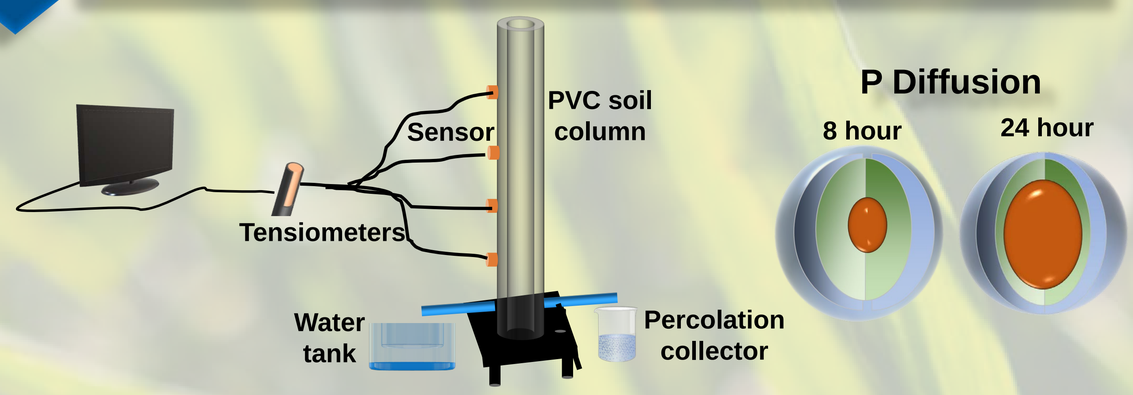


Conclusions

1. Synthesised P-enriched BC with slow-release characteristics
2. Amino clay modification can improve **uniformity** in soil profile distribution, thus lowering **stratification**

4. Future Plans

2024 Synthesise BBF granules and investigate dissolution kinetics and diffusion of P from fertiliser granules in soils



2025 Conduct plant pot experiments and field trials in collaboration with industrial partners.

Plant growth without BBF

Plant growth with BBF

2025 Investigate possibility of using Amino clay monoliths without BC loading as potential fertiliser to tackle P stratification in Australia

SOIL CRC

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