Evaluating the fertilizer effects of mechanochemically treated calcium-carbonate materials with potassium phosphate using a soil-plant model system

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INTRODUCTION

The reuse of eggshell and spent lime to produce more sustainable fertilizers provides added value using waste and meet sustainability criteria. Mechanochemical processes have proven to promote the reactivation of carbonates without the need of solvents. A previous study reported the formation of calcium and potassium (hydrogen) phosphates from eggshell and KH_2PO_4. However, the calcium and potassium phosphates have not yet been tested in a soil-plant system, being crucial for its validation as a plant fertilizing product.

AIMS & SCOPE

The aims of this study were to investigate:

1. **mechanochemical reaction between different sources of calcium carbonate and KH_2PO_4 to produce a slow-release phosphorus (P) fertilizer;**
2. **the proposed slow-release fertilizing efficiency compared with a negative control (rock phosphate) and a positive control (KH_2PO_4) in a greenhouse study.**

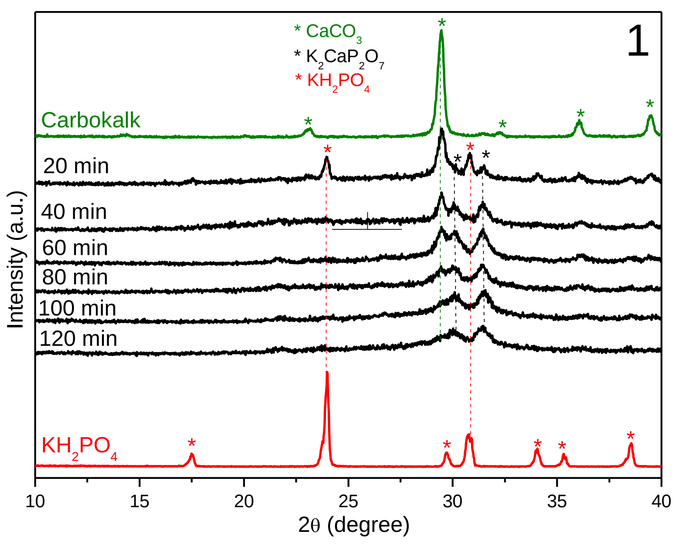
RESULTS

Better nutrient management

Rock phosphate
Negative control

K-Ca-P
Slow release fertilizer

KH_2PO_4
Positive control



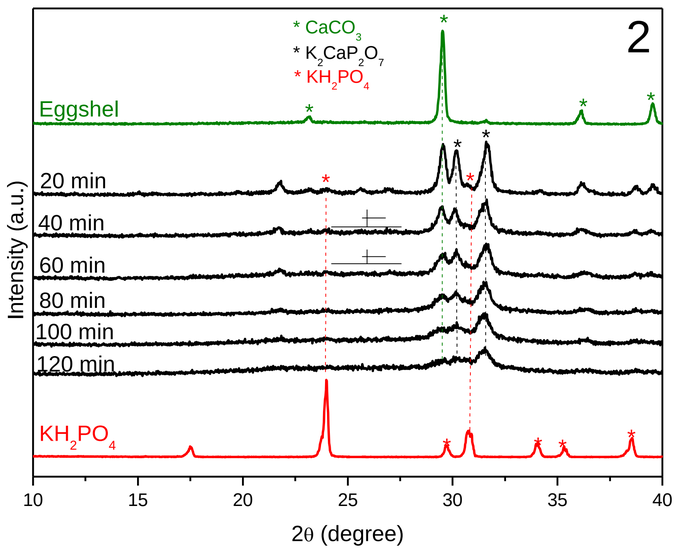
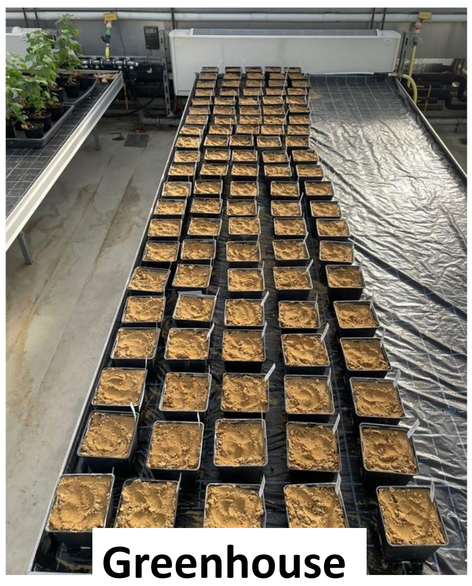
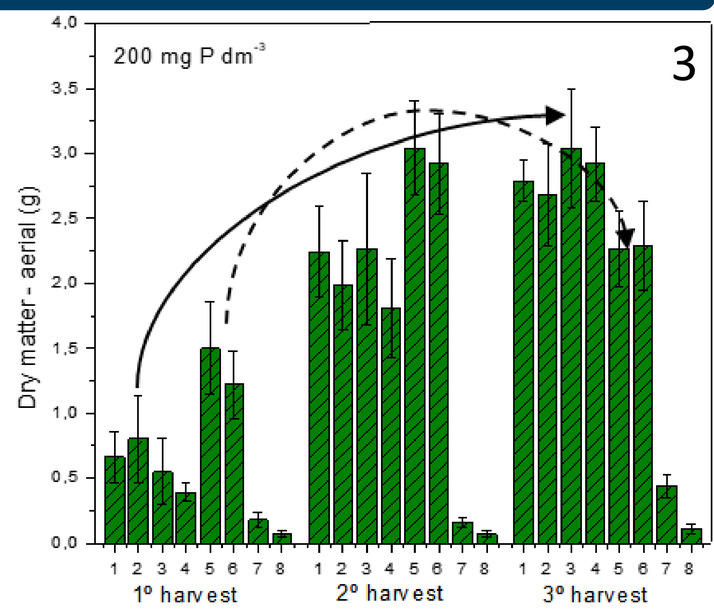


Figure 1 and 2 XRD analysis of the prepared materials.





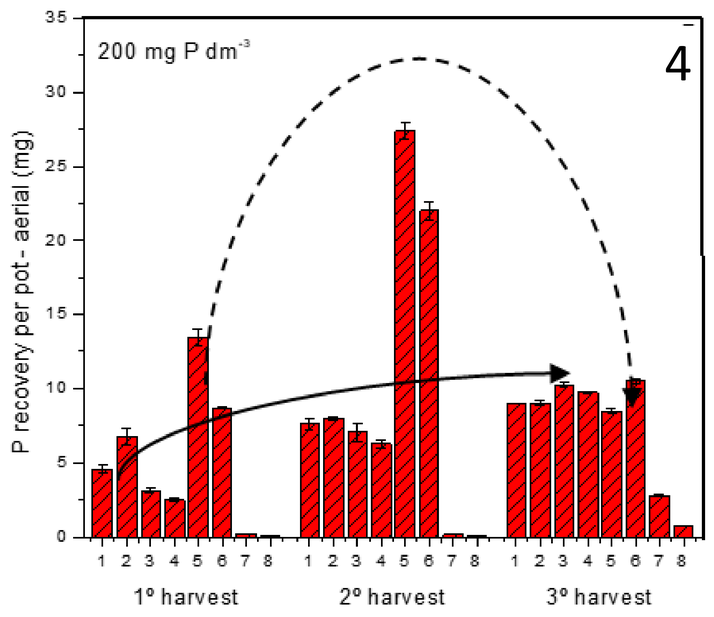


Figure 3 and 4: dry matter production and P recovery per pot considering 200 mg of P per pot.

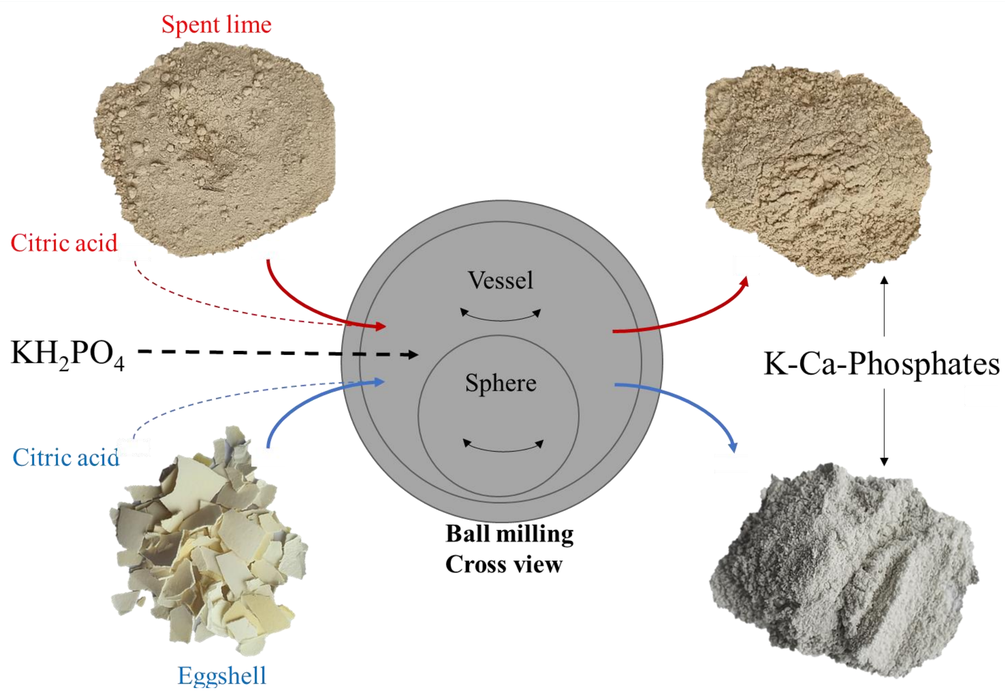
MATERIALS, METHODS & EXPERIMENTAL SETUP

Synthesis of the slow-release fertilizer

Two alternative sources of calcium carbonate ($CaCO_3$): Spent-lime from sugar beet industry and eggshell. High-soluble fertilizer used: KH_2PO_4. Milling conditions: Impact ball mill, 100 min, 30Hz, $CaCO_3$:KH_2PO_4 molar ratio 1.25:1, with and without citric acid (10%, wt/wt).

Greenhouse experiment

Plant-model: *Brachiaria brizantha*. Experimental set-up: 2 dm^3 of sandy substrate, 200 mg and 400 mg of P per pot, 2 plants per pot. Greenhouse conditions: 25ºC, 75% humidity, for three months, including three harvests.



SUMMARY

- **Successful mechanochemical reaction producing new Ca-K-P phases with P slow-release behavior.**
- **The proposed slow-release P fertilizer present a more linear effect on biomass production and nutrient uptake.**

CONCLUSION & OUTLOOK

- The proposed method can be used to promote the circular bio-economy using residues to produce new fertilizer materials.
- The proposed material represent a potential alternative P fertilizer, supporting nutrient recycling and management.

REFERENCES: