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ASSESSING THE EFFECT OF POLY4 ON SOIL ENVIRONMENTS

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Highlights

- Soil physical properties' analysis shows that POLY4 application maintained soil aggregate stability or its resistance to compaction and erosion. This is a positive – the soil is not being broken down and washed away by water, which is the main cause of erosion.
- Nutrient leaching results' analysis indicates that POLY4 application decreased the loss of phosphates (PO_4-P) from the soil. It is a positive – POLY4 can keep P in the soil to:
  - Stimulate crop growth;
  - Support the P nutrient legacy in the following seasons;
  - Reduce pollution risk by keeping phosphorous in the soil and reducing its entry into waterways.
- Use of POLY4 resulted in a higher level of dissolved organic carbon (DOC), which is important to the soil environment and health, and is an indicator of the soil's organic matter content level.

Summary

Granular polyhalite at 110 kg Ca ha^{-1}:

A. Limited evidence of change in soil surface physical properties at the mesocom scale;

B. Higher retention of PO_4-P residue and DOC after first application.

Introduction

Polyhalite is an evaporite mineral with the chemical formula $K_2SO_4.MgSO_4.2CaSO_4.2H_2O$. Previous work on granulated polyhalite (POLY4) indicated differences in mechanical behaviour of polyhalite treated soils under laboratory conditions for tensile strength. The current work investigates the effect of polyhalite at the mesocosm scale on the susceptibility of soil to surface erosion and nutrient leaching.

Calcium, in amendments such as gypsum, are often used to help remediate physically degraded soils and to improve nutrient retention for agriculture. The divalent cation (Ca^{2+}) can encourage flocculation by bonding clay particles together. Increased flocculation can aid further retention of other divalent cations such as Mg^{2+} and K^+ important for plant growth.

Polyhalite nutrient content

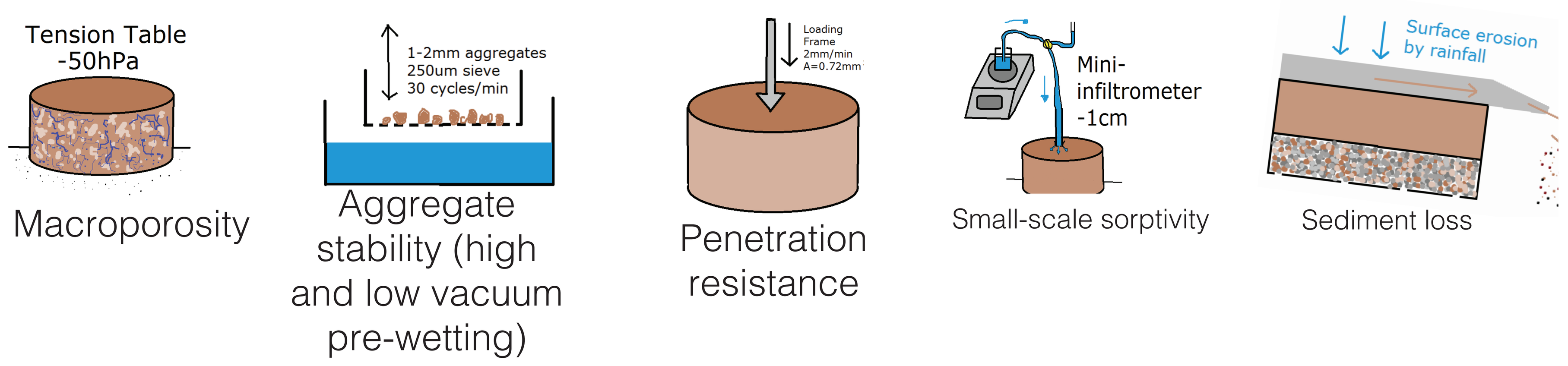
K^+	11.6%	K_2O	14%
Ca^{2+}	12.2%	CaO	17%
Mg^{2+}	3.6%	MgO	6%
S	19.2%	SO_3	48%

Materials and methods

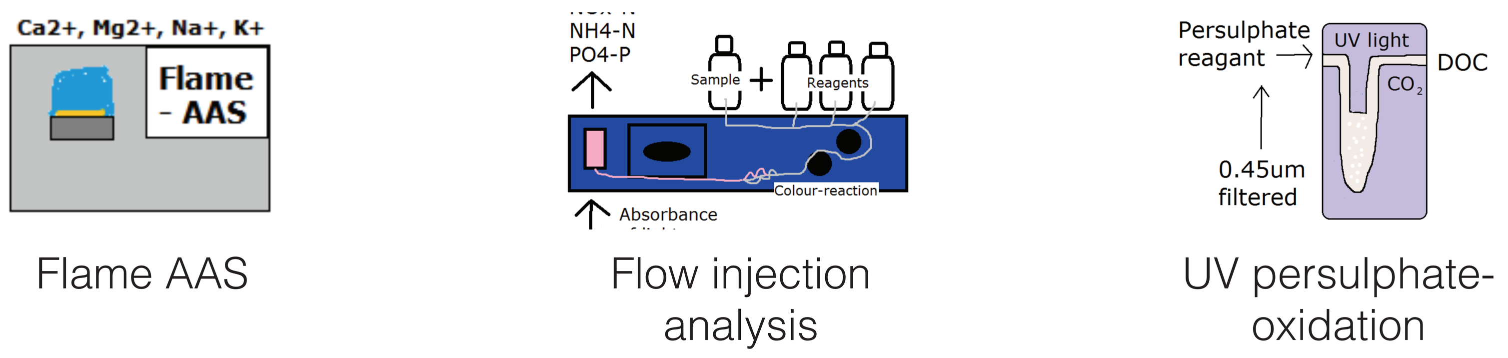
Heavy rainfall simulations (30 mins at 80mm hr^{-1}) on mesocosms with:

- Two soil types; four reps;
- Cambisols with sandy loam (Insch) and silty loam (Pow) texture;
- Two applications of 0 or 110kg Ca ha^{-1} granulated polyhalite;
- Three x rainfall simulations after 1, 2 and 3 extreme wet-dry cycles respectively;
- Core samples taken after each.

A. Soil physical properties:



B. Nutrients in run-off and leachate:



Discussion

A. Physical properties:

The following physical properties were unaffected on either soil type:

- Macropore volume at - 50hPa;
- Microscale penetration resistance;
- Small scale sorptivity (on core surface or sub-surface);
- Particle weight in runoff;
- Aggregate stability via fast wetting/low vacuum or fast wetting/high vacuum methods (see Figure 2).

This evidence suggests that the physical impact from Ca^{2+} (and other cations) from polyhalite at annual fertilizer application rates is not significant at this scale. Clay content of <20% in both soil types suggests physical properties are driven by organic matter interactions than ionic interactions between Ca^{2+} and clays. Effects on physical properties might be observed under real world spatial scale as a result of cumulative applications representative of agricultural systems.

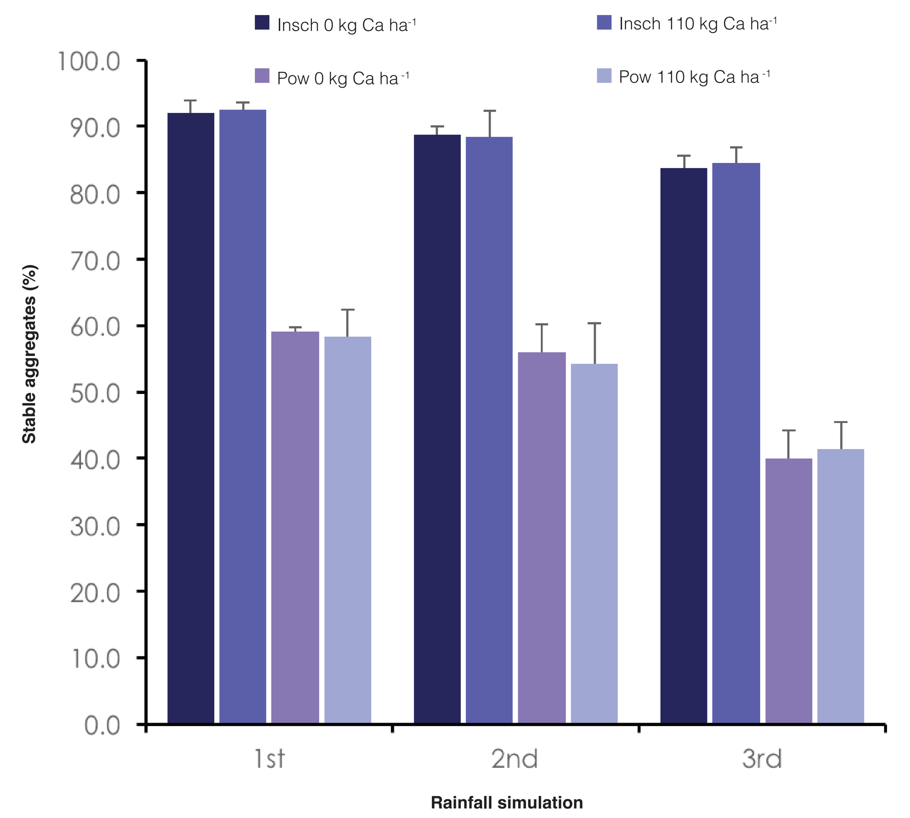


Figure 2
Aggregates have equal stability whether the soils have polyhalite added or not.

B. Nutrient leaching:

Analysis of nutrient leachate collected underneath each sample found significant differences in DOC (Figure 3) and phosphates (Figure 4).

The addition of Ca^{2+} can bind with soil phosphates and lead to retention of phosphorus, an important plant nutrient and known water pollutant. Ca^{2+} can also bind with DOC to form complexes that can be beneficial to soil health.

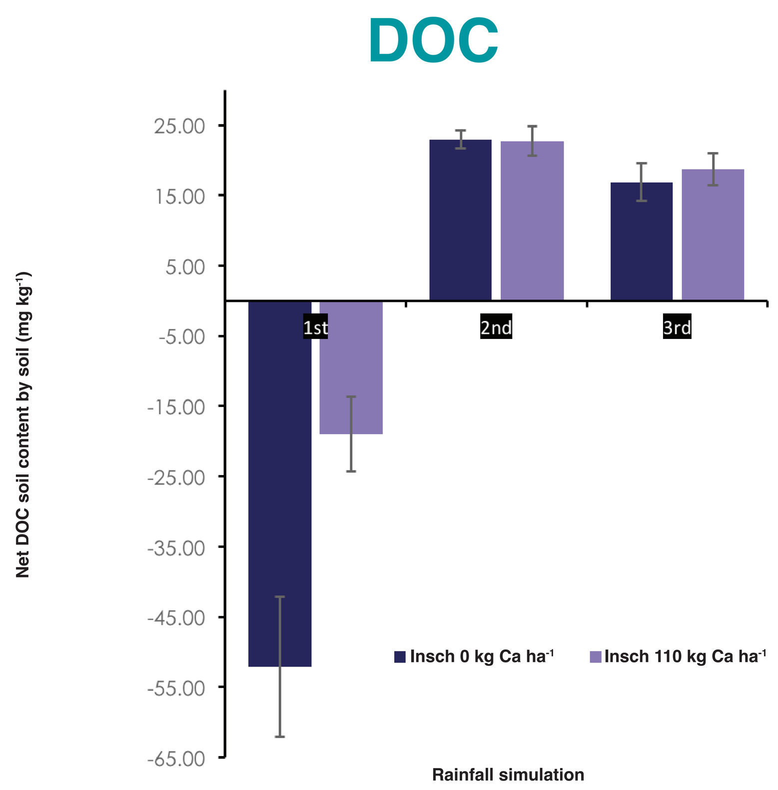


Figure 3
DOC (mg kg^{-1}) remaining in soil. First rainfall simulation is significant at ($p<0.001$); not significant for other soil.

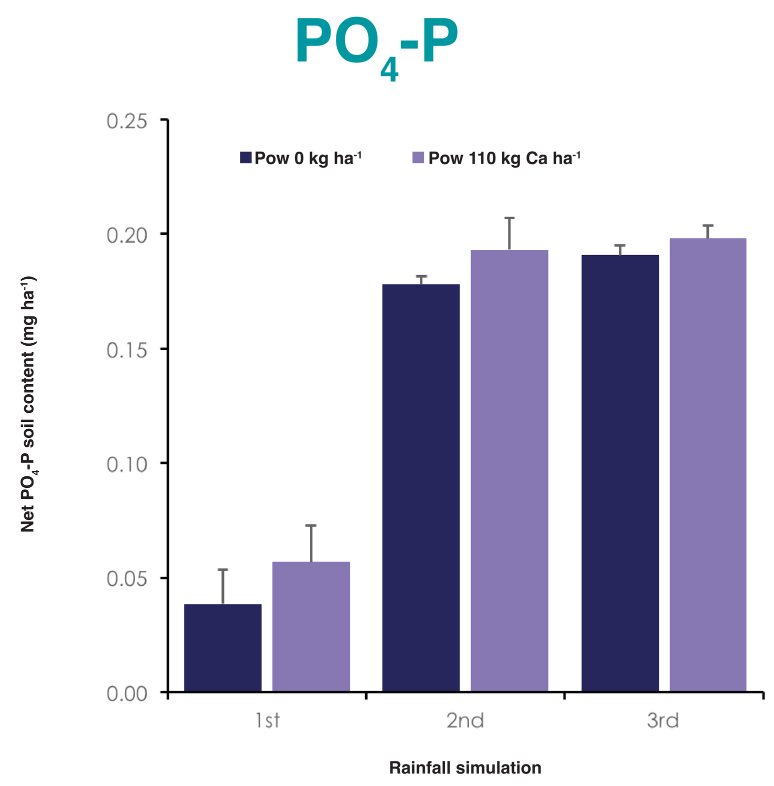


Figure 4
Polyhalite application decreased PO_4-P loss in one of the soils ($p=0.01$) but not the other.