ASSESSING THE EFFECT OF POLY4 ON SOIL ENVIRONMENTS


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Summary
Granular polyhalite at 110 kg Ca ha⁻¹:
A. Limited evidence of change in soil surface physical properties at the mesocosm scale;
B. Higher retention of PO₄-P residue and DOC after first application.

Introduction
Polyhalite is an evaporite mineral with the chemical formula K₂SO₄·MgSO₄·2CaSO₄·2H₂O. 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 (Ca²⁺) can encourage flocculation by bonding clay particles together. Increased flocculation can aid further retention of other divalent cations such as Mg²⁺ and K⁺ important for plant growth.

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:

<table>
<thead>
<tr>
<th>Physical property</th>
<th>Measurement</th>
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<tbody>
<tr>
<td>Macroporosity</td>
<td>Tension Table at -50hPa</td>
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<tr>
<td>Aggregate stability</td>
<td>High and low vacuum pre-wetting</td>
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<td>Penetration resistance</td>
<td>Micro penetrometer 1cm</td>
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<td>Small-scale sorptivity</td>
<td>Sediment loss</td>
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B. Nutrients in run-off and leachate:

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Measurement</th>
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</thead>
<tbody>
<tr>
<td>Flame AAS</td>
<td>Flow injection analysis</td>
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<td>UV persulphate-oxidation</td>
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</tbody>
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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 subsurface);
- 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 Ca²⁺ (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 Ca²⁺ and clays. Effects on physical properties might be observed under real world spatial scale as a result of cumulative applications representative of agricultural systems.

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 Ca²⁺ can bind with soil phosphates and lead to retention of phosphorus, an important plant nutrient and known water pollutant. Ca²⁺ can also bind with DOC to form complexes that can be beneficial to soil health.