Capsella bursa-pastoris L. Medik. (shepherd’s purse) myxosperous seed mucilage mechanically stabilises clay soil

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Introduction

• Capsella bursa-pastoris L. Medik (shepherd’s purse) seeds are myxosperous. That is, they exude mucilage upon hydration.
• Myxospermy appears to be of great ecological importance in water limited environments.
• The utility of the mucilage to improve soil mechanical properties was investigated.
• Rheology measures assessed the physical properties of a model (clay) soil, before and after the addition of extracted seed mucilage.

The theory of rheology

• Rheology is the science of material deformation and flow.
• Materials may range from ideal-elastic to ideal-viscous.
• The parameters assessed for this study are defined below.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Rheology</th>
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<tbody>
<tr>
<td>τ</td>
<td>Rotational shear stress</td>
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<tr>
<td>γ</td>
<td>Shear strain</td>
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<tr>
<td>η</td>
<td>Viscosity (Pa-s)</td>
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<tr>
<td>G'</td>
<td>Complex shear modulus (Pa), a measure of stiffness,</td>
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<tr>
<td>G''</td>
<td>Storage modulus (Pa), represent elastic behaviour,</td>
</tr>
<tr>
<td>G''</td>
<td>Loss modulus (Pa), represent viscous behaviour,</td>
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<tr>
<td>tan δ</td>
<td>Loss factor (1), where is the phase shift angle,</td>
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<tr>
<td>τf</td>
<td>Yield stress (Pa), represent a critical stress that causes irrecoverable deformation</td>
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<tr>
<td>τr</td>
<td>Stress at flow point (Pa), where material start to flow</td>
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</tbody>
</table>

Methods:

Seeds were washed in dH20 (1:10 (w/v)) with shaking, 8h. After centrifugation (5000 rpm, 20 min), the mucilage-containing supernatant was freeze-dried. Mucilage was added to soil (a Ca-montmorillonite (clay) at 0.5 and 1 % (w/w), at soil water contents ranging from 140 - 200 % (w/w) of clay weight. Shear stress (τ) was applied (0.1 - 10000 Pa @ Temp. = 20 °C ; frequency = 0.5 Hz; gap = 2 mm).

Results

• Soil rheology parameters (G', G'', η, τf, τr, tan δ) decrease as water content increases.
• The rate of this decrease is reduced when is seed mucilage present.
• There is less affect of seed mucilage on soil shear modulus and viscosity.
• The greatest affect of the seed mucilage is seen for yield– and flow-shear stress (soil stiffness).
• This influences at high soil water content, even for only 0.5 (w/w) mucilage.
• At low water contents 1 % mucilage has greater influence than 0.5 % mucilage.
• Soil water content and rheology-measure relationships are explained by exponential curve fits.
• Seed mucilage increases soil resistance to mechanical stress, even at low concentrations
• This insight will be exploited using mathematical modelling, to facilitate an assessment of the ecosystem services provision that might be made by myxosperous seeds.

Conclusions

Further Reading

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