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Mechanical impedance of soil crusts and water content in loamy soils

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Soil crust development affects soil water dynamics and soil aeration. Soil crusts act as mechanical barriers to fluid flow and, as their mechanical impedance increases with drying, they also become obstacles to seedling emergence.

As a consequence, the emergence of seedling cohorts (sensitive seeds) might be reduced. However, this may be of interest to be used as an effective system of weed control.
Soil crusting is determined by several factors: soil texture, rain intensity, sedimentation processes, etc. There are different ways to characterize the crusts. One of them is to measure their mechanical impedance (MI), which is linked to their moisture level.
In this study, we measured the evolution of the mechanical impedance of crusts formed by three loamy soil types (clay loam, loam and sandy clay loam, USDA) with different soil water contents.

The aim of this communication was to establish a mathematical relationship between the crust water content and its MI. A saturated soil paste was prepared and placed in PVC cylinders (50 mm diameter and 10 mm height) arranged on a plastic tray. Previously the plastic tray was sprayed with a hydrophobic liquid to prevent the adherence of samples. The samples on the plastic tray were left to air-dry under laboratory conditions until their IM was measured.
To measure IM, a food texture analyzer was used. The equipment incorporates a mobile arm, a load cell to apply force and a probe. The arm moves down vertically at a constant rate and the cylindrical steel probe (4 mm diameter) penetrates the soil sample vertically at a constant rate. The equipment is provided with software to store data (time, vertical distance and force values) at a rate of up to 500 points per second. Water content in crust soil samples was determined as the loss of weight after oven-drying (105°C).

From the results, an exponential regression between MI and the water content was obtained (determination coefficient very close to 1).

This methodology allows the prediction of the potential mechanical behaviour of soil crusts generated during soil drying, from initial saturated soil conditions (e.g. waterlogging conditions).