



Impact of cover crop roots on soil structure and erosion mitigation

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The use of cover crops is a well-established soil conservation technique and has been effectively used in soil erosion control in many arable systems. Arable lands differ in environmental conditions and crop rotations, demanding bespoke mixtures of cover crops. A study was conducted to compare how the root system of seven different cover crops (oat, rye, buckwheat, vetch, radish, mustard and phacelia) with different root structures can contribute to changes in soil physical properties. The overall aim of the study is to identify bespoke cover crop mixtures with optimal root traits to maximize soil resistance to soil erosion by water and to improve soil structure for enhanced water infiltration and optimized crop growth.

A greenhouse, monoculture experiment was carried out in large containers (1m x 1.2m x 0.8m) on a sandy clay loam soil. The topsoil had a BD of 1.2 g cm³ sitting on a compacted subsoil (BD = 1.5 g cm³). The cover crops were grown for 90 days. Concentrated flow experiments were conducted with a hydraulic flume. Data was collected on root induced soil aggregate stability, soil penetration resistance (PR), bulk density (BD) and relative soil detachment rate. Root traits (root density (RD), root length density (RLD) and root surface area density (RSAD)) were measured in relation to the soil data.

The results show that the root induced soil aggregate stability was increased compared to the control (no plants) by the presence of buckwheat, rye, oat, mustard, radish and phacelia roots, with values ranging from 0.76 to 0.35 g g⁻¹. Vetch performed similar than the control samples. Phacelia, vetch and the control samples showed a significantly lower ($F(7,22)=4.75$, $p=0.005$) root induced soil aggregate stability compared to the other species. Bulk density showed a moderate increase in all treatments when compared to the baseline due to irrigation over time.

The lowest PR values were measured in the control treatment across the entire soil profile. Vetch showed the highest PR in the topsoil and radish had the highest values in the subsoil. Oat, radish and mustard had lowest PR values in the topsoil as mustard and buckwheat had the lowest PR values amongst all cover crop species in the subsoil.

The RD values ranged between 0.035 kg m⁻³ (buckwheat) and 1.09 kg m⁻³ (phacelia). RLD ranged between 0.903 km m⁻³ (vetch) and 16.11 km m⁻³ (phacelia). RSAD ranged between 1.56 m² m⁻³ (buckwheat) and 15.53 m² m⁻³ (phacelia). The absolute erosion rates ranged from 0.477 kg m⁻² s⁻¹ (vetch) to 0.0095 kg m⁻² s⁻¹ (phacelia). Rye, mustard and phacelia were most effective at reducing soil erosion by concentrated flow at an early establishment stage.