Soil health and function

Physical characteristics, function, and soil health status of compost amended soil

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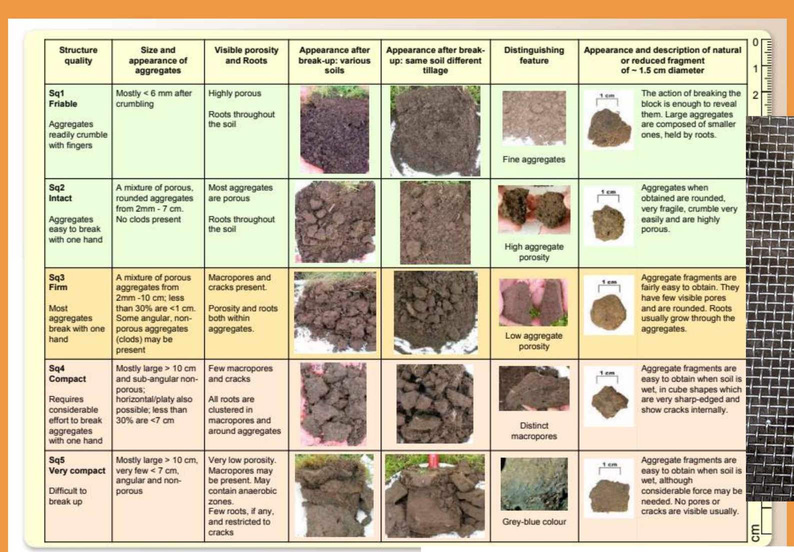
Introduction

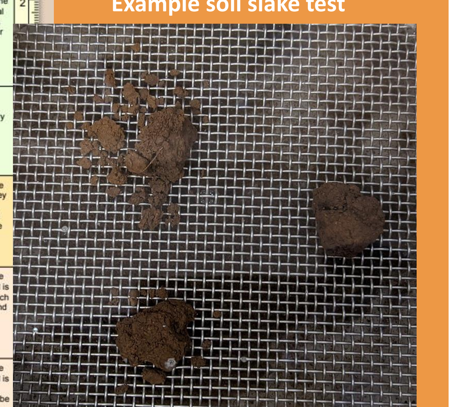
Soil physical structure underpins different soil functions. These functions are critical with significant spatial contributions from field to the catchment and the wider environment. Examples of such functions include flood mitigation, reducing soil erosion, and influencing greenhouse gas emissions from soil.

Sustainable management of agricultural soils aims to optimise soil physical condition ensuring that soil functions are maintained. The application of indicators to characterise soil health is key in both top- and sub-soils to monitor and assess soil ecosystem services.

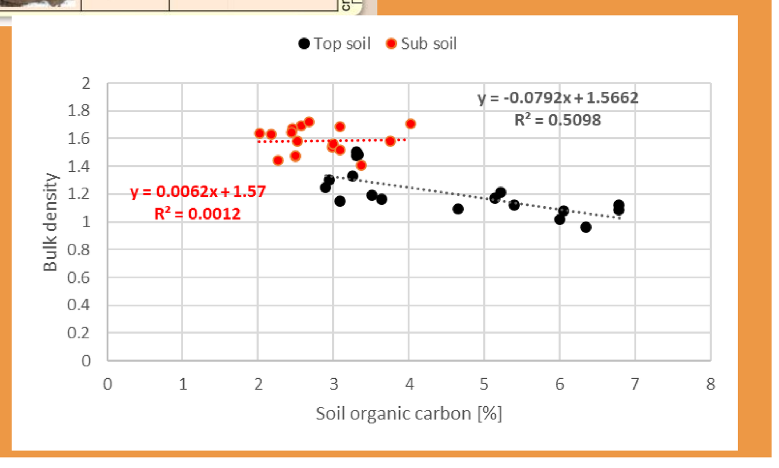
There are a number of tools to characterise soil structure (e.g., aggregates) such as the Visual Evaluation of Soil Structure (VESS) and the slake test. These are reported to work well under typical conditions. However, questions must be asked on their efficacy under different soil management regimes. Furthermore, it is important to understand how these indicators link to soil physical functions such as water holding capacity, hydraulic conductivity, plant available water, and soil resilience to compaction.



Visual Evaluation of Soil Structure (VESS) chart



Example soil slake test



Soil organic carbon relationship to soil bulk density in top-soil and sub-soil

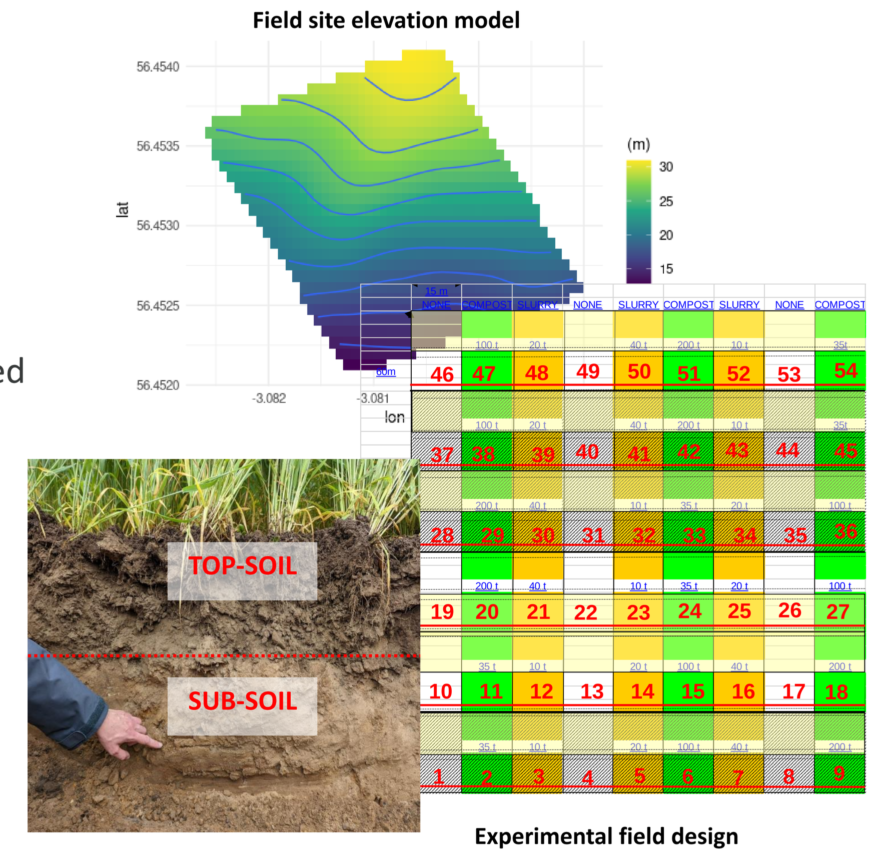
Methods

Intact soil cores and bulk soil was collected from a long-term compost amendment platform (Compost treatments prefixed 'C': 200 t/ha [C200]; 100 t/ha [C100]; 35 t/ha[C35]; Control: no organic amendment) to assess soil functional performance in relation to typical soil health indicators. Indicators tested included VESS, bulk density, soil carbon, and the slake test. To validate these tools laboratory testing was performed on intact cores and field sampled bulk soil to characterise soil physical properties.

Objective

- Characterise the **influence of compost** amendment on **top-soil** and **sub-soil structure**
- **Validate indicators** to soil **functions**
- Measure the **resilience** of both **top-soils** and **sub-soils** to **compaction**
- Compare the **VESS** (qualitative) tool to quantitative assessments of **soil structure** using **wet sieving** approaches

Field site elevation model



Experimental field design

Results

- Analysis of variance showed **plant available water** was **significantly different between treatments** within top-soil ($P<0.001$) and subbsoil ($P<0.05$) with compost increasing available water (Figure 1)
- **Significant increase** ($P<0.01$) **of water stable aggregates** with increasing compost-application was observed in top-soil (80.79% ± 2.4 in C200 vs 65.1% ± 2.9 in control) (Figure 2A). In contrast, sub-soil results suggested that **compost had little impact on water stable aggregates** and in some treatments reduced the proportion of water stable aggregates (Figure 2B)
- **Significant differences in top-soil VESS** score were observed ($P<0.01$) but **no differences in slake test score** ($P=0.836$) (Figure 2A and 2B). Within **sub-soils, slake** scores were **significantly different** ($P<0.05$) (Figure 2B)
- **Compost** was found to have a **significant effect on hydraulic conductivity** (Figure 3) in top-soils ($P<0.01$) and sub-soils ($P<0.001$)
- Traces for **compaction resilience** were **markedly different** between treatments (Figure 4) as was the soils rebound potential following the removal of load (Figure 5)

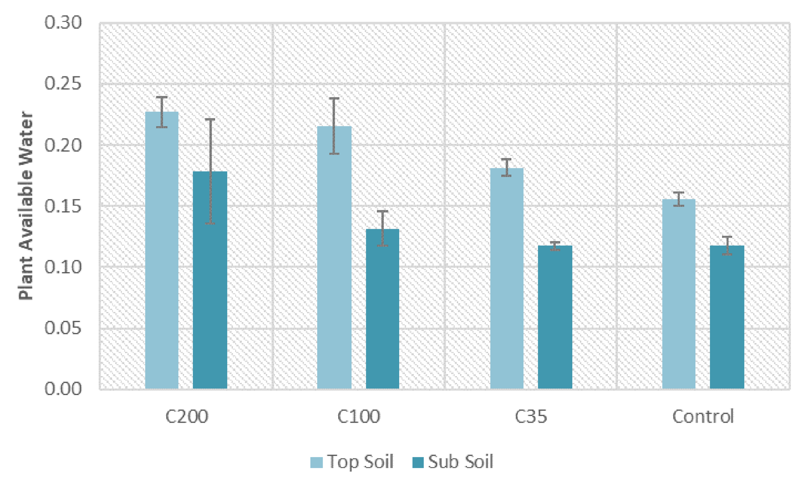


Figure 1: Plant available water (5 – 1500 kPa) for plots with compost applied at rates of 0 to 200 t ha

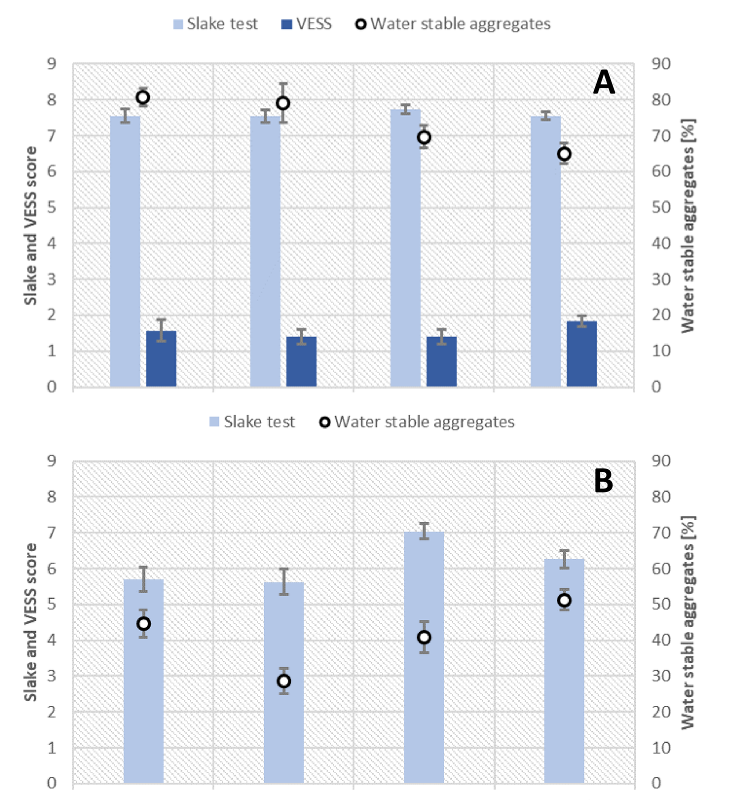


Figure 2: Soil health structural indicator scores (slake and VESS) and proportions of water stable aggregates under different compost application rates (0 to 200 t ha) in top-soil (A) and sub-soils (B)

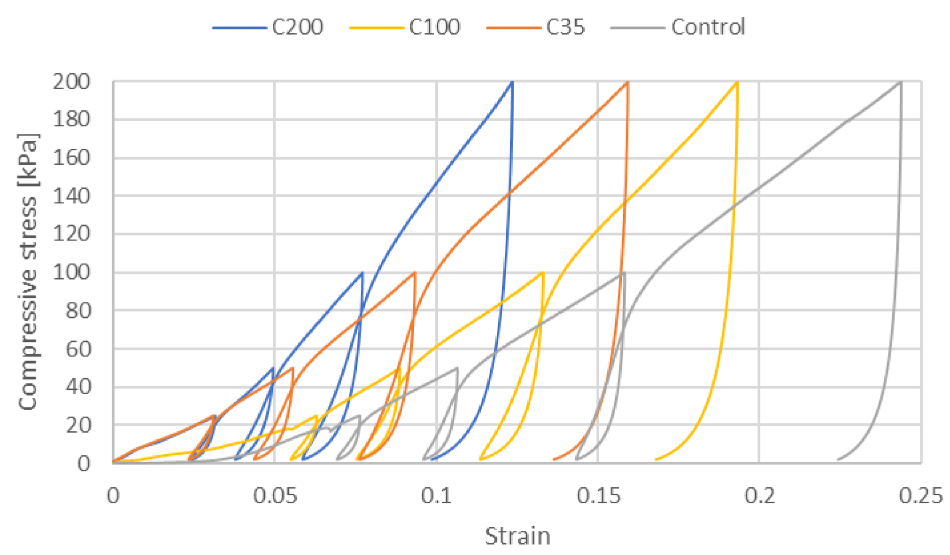


Figure 4: Example compressibility traces of surface soils under different compost application rates, increasing strain indicates increasing compaction to achieve required load/ compressive stress. Application of stress to 25, 50, 100, and 200 kPa followed by relaxation at each level of stress

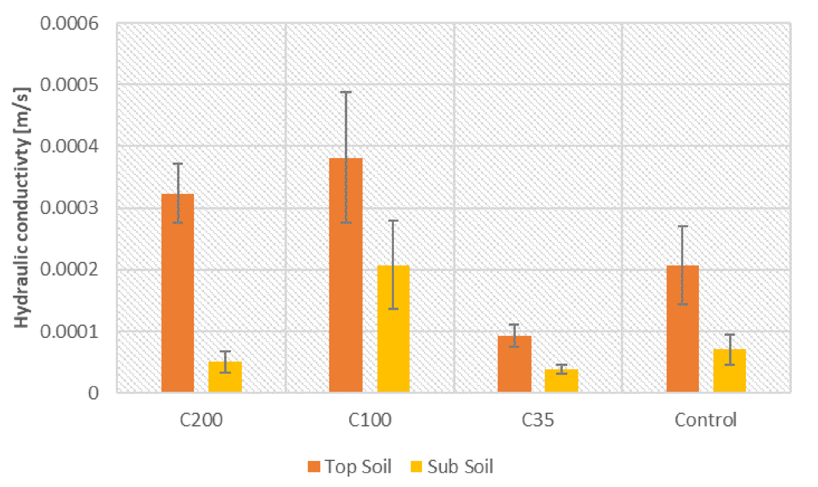


Figure 3: Soil hydraulic conductivity in top-soil and sub soil with increasing compost application rate

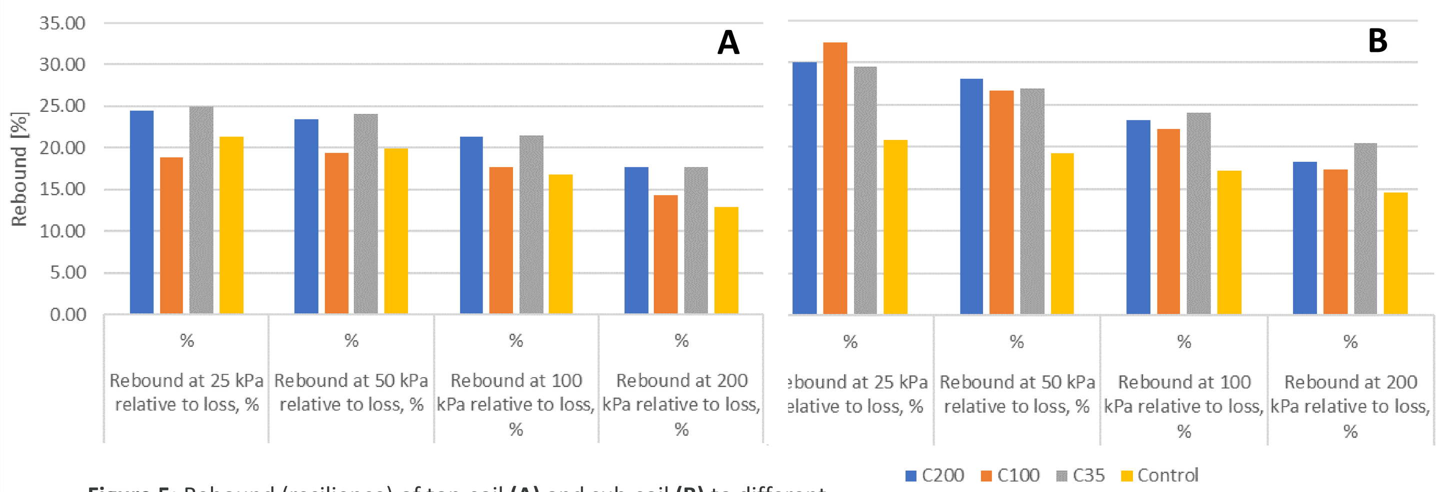


Figure 5: Rebound (resilience) of top-soil (A) and sub-soil (B) to different levels of applied stress and compost application rates

Conclusions

- In top-soils **plant available water** and **water stable aggregates (WSA)** was shown to **increase significantly with increasing compost application rates** similar to that observed with Dexter S (data not shown)
- Hydraulic conductivity in top-soil was found to be higher in plots with the highest rates of compost application
- **Sub-soil hydraulic conductivity** in moderately applied compost plots was **significantly higher than in control plots**
- Even under **minimum tillage conditions** changes, **significant changes in sub-soil** function were observed with **compost application**
- **No link observed between organic carbon in subsoils and bulk density**

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