THEME 2

C–structure-relations in aggregated soils subjected to different tillage intensity

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INTRODUCTION

What is known?

Mitigating losses of Soil Organic Carbon (SOC) in arable soils

Physical protection mechanism: Inside intact aggregates, SOC is physically protected against microbial attack since microorganisms, as potential decomposers, cannot access these pores or are inactive due to limited oxygen, water and energy supply;

Importance of aggregate strength: Susceptibility against SOC losses is related to stress-induced changes in aggregation and internal pore structures, and depends therefore on the mechanical strength properties.

Effect of tillage intensity: No-tillage versus Ploughing

Tillage controls the SOC distribution within soil depth;

Ploughing inhibits aggregation processes by mechanical disruption of aggregates: Physically protected SOC becomes accessible for microbial decomposition (CO_2-release).

OBJECTIVES

- To determine how the spatial SOC distribution and stabilization potential within large macro-aggregates (5 – 20 mm across, Fig. 1) are influenced by soil tillage intensity;
- To determine how aggregate strength and related SOC loss potential are changed by the soil tillage intensity;

Material: Undisturbed soil samples, 0–10 cm, 10–20 cm depths (Stagnic Luvisol from glacial till);

Tillage treatments (established 9 years ago): Conventionally (CT), reduced (harrowed to 8-10 cm depth, CONS), no-tilled (NT).

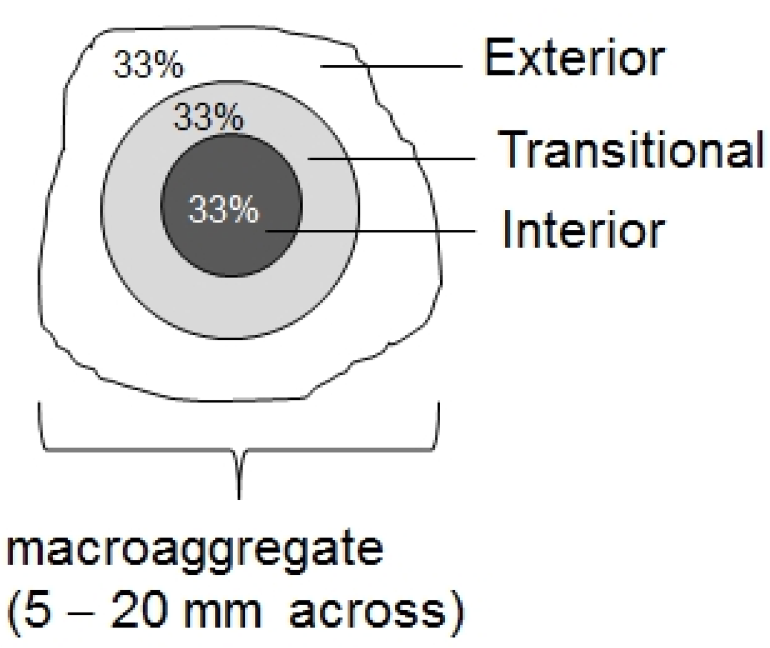

Fig. 1: Separation of concentric layers of equal solid mass ratio within macroaggregates using the SAE method by Park & Smucker (2005)

MAIN RESULTS

SOC distribution inside aggregates (Fig 2a):

- Higher depletion of SOC in aggregate exterior regions with increasing tillage intensity;
- Lowering the tillage intensity increased accumulation of SOC in exterior compared to interior aggregate regions (SOC gradient for 80% of NT aggregates).

SOC stocks inside aggregates (Fig 2b):

- SOC stock within macro-aggregates was almost 2/3 as large, increasing from 15 t/ha (CT) to 26 t/ha (NT) summed up at 0 – 20 cm depth.

Aggregate strength inside aggregates (Fig 3):

- With increasing tillage intensity (NT < CONS < CT) aggregates were less stable (lower E_s), which likely prevents the establishment of concentric SOC gradients from exterior to interior regions.

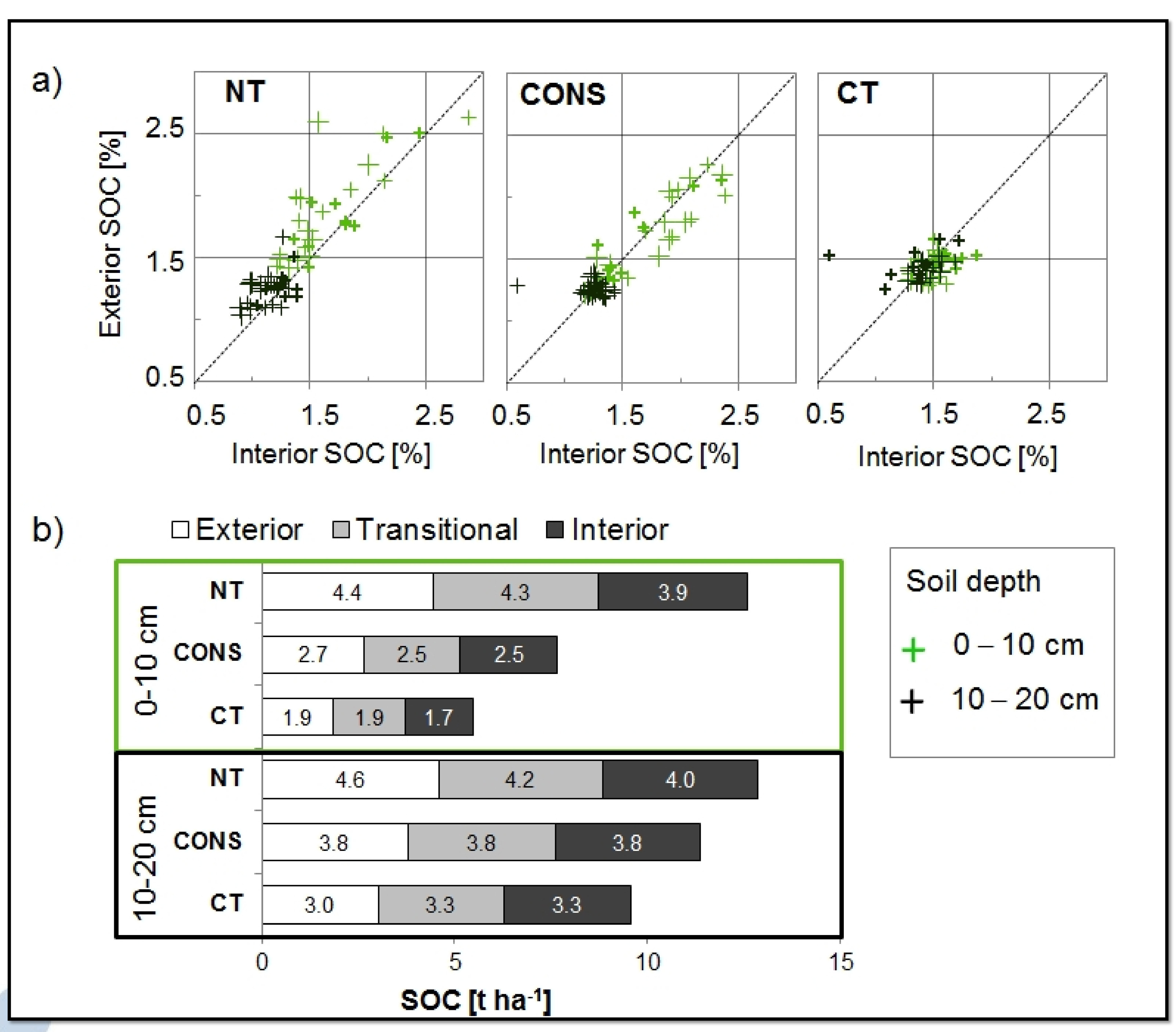

Fig. 2: Relation between exterior and interior SOC within macroaggregates (5–20 mm across) (details see: Mordhorst et al. 2013) (a) and calculated mean SOC stocks of concentric aggregate layers (b) depending on tillage treatment (n=30).

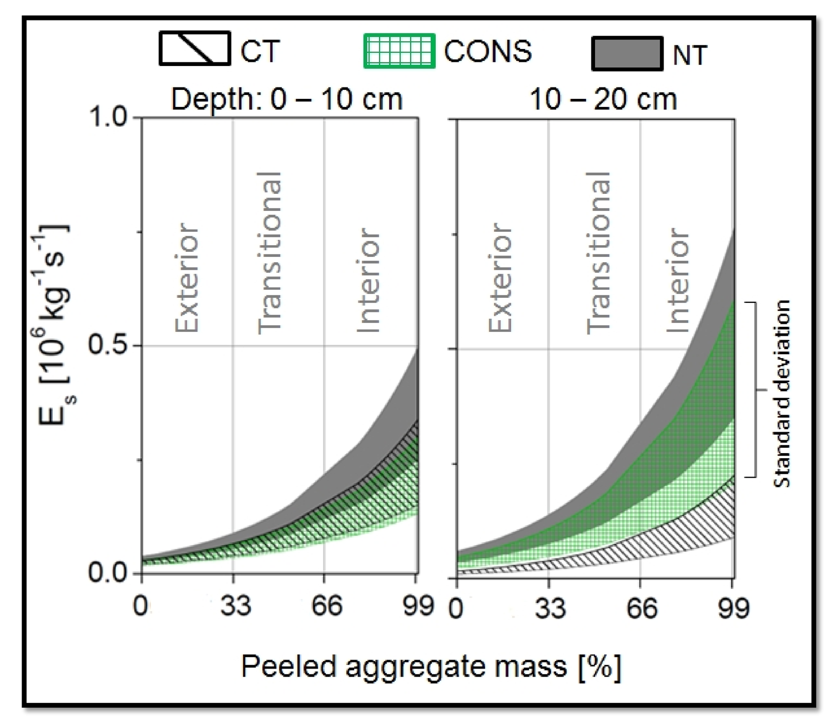

Fig. 3: Erosive strength (E_s) of concentric layers within 12–20 mm aggregates obtained from 0–10 and 10–20 cm depths for different tillage treatments (published in Mordhorst, 2013). E_s was calculated from abrasive forces, which were required for peeling the aggregates from exterior to interior regions (n=10)

CONCLUSION

Importance of minimizing aggregate turnover rates for improving carbon sequestration:

- The establishment of SOC gradients within aggregates possesses a great potential for SOC sequestration, but requires a low turnover rate (NT) to increase internal aggregate porosities over time in order to expand the SOC storage towards interior regions;
- Investigation of carbon-structure relations on that scale size has proven to be valuable for evaluating the effect of management (e.g. soil tillage systems) on the susceptibility against mechanical disturbance and accompanied CO_2-release that diminishes the carbon sequestration potential (Mordhorst *et al.* 2014).