Managing roots to foster soil organic carbon storage

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Soil multifunctionality as key for a sustainable future





Kopittke et al., Critical Reviews in Environmental Science and Technology. 2022

Aggregates as integral soil structure fostering C storage



Witzgall et al. Nature Comms. 2021

C Pools in Soil - particulate vs. mineral-associated organic matter



remnants (e.g. fungal hyphae)

→ mainly **microbial residues** in patches on mineral surfaces (clay, FeO oxides etc.)

Mueller et al. 2012 SSSAJ; Prater et al. 2020 Biogeosciences; Spohn et al. 2020 GCB

Roots as major factors determining soil carbon stocks



Samples from three sites with different parent materials (Northern Germany)

Haplic Cambisol, tertiary sand Haplic Luvisol, loess Eutric Cambisol, basalt



Angst et al., Soil Biol. Biochem. 2018

How do tree roots affect soil aggregation? Vera Baumert et al. SBB 2020

Growing **European beech** (Fagus sylvatica L.) seedlings in top and subsoils of **3 different parent materials**





Photos: Vera Baumert

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Rooting fosters OC storage in macroaggregates in subsoils



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From Photosynthesis to roots and soil organic carbon



"DOK" trial – agricultural cropland (Therwil, Switzerland) Haplic Luvisol, alluvial loess



Vidal et al. Frontiers in Env. Sci. 2018

Wheat rhizosphere "DOK" trial – tracing photosynthate carbon

rhizosphere cross section



tracing C allocation from plants to microorganisms and mineralassociated organic matter (sub-structure – microaggregate)

Vidal et al. Frontiers in Env. Sci. 2018

C allocation from plant to microorganisms and soil ¹³C from Photosynthesis



Rhizosphere microorganisms consume root and soil derived OM Transfer of root derived OM via microorganisms in soil microaggregates

Vidal et al. Frontiers in Env. Sci. 2018

Rhizodeposition – soil structure and C sequestration

→ roots are crucial for OM input throughout whole soil profile important to be included in C modelling

→ root exudates trigger macroaggregation in subsoils previously unknown effect of exudates in deeper soil layers, fostered by fungi - extended rhizosphere (mycosphere)

→ global warming / elevated CO₂ lead to increase in rooting and rhizodeposition (Phillips et al., 2011; Yin et al., 2013) increased importance of rhizodeposition for subsoil C storage?

Rhizodeposition – soil structure and C sequestration

→ drought has the potential to strongly alter SOC dynamics and soil aggregation in the rhizosphere ecological consequences?

→ cultivar effects shape feedback of drought on rhizosphere soil aggregation and SOC dynamics

drivers of intra-specific variations?