Soil CO_2 and N_2O fluxes under wheat and barley in a conventional vs. reduced tillage field-trial in Germany

Project website

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1. Introduction

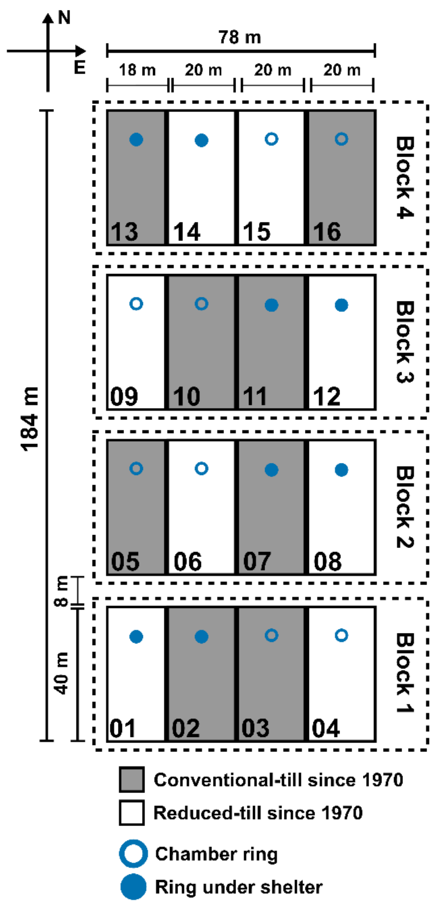
Reduced tillage (RT) is a widely applied practice assumed to promote **organic carbon (OC) sequestration** in the topsoil compared to **conventional tillage (CT)**. However, it is unclear how **long-term** applications of reduced tillage will affect yield, soil OC and **greenhouse gas (GHG)** emissions especially under drier (future) conditions.

2. Design

Garte-Sued is a **field-trial** comparing CT and RT in a Luvisol (silt =73%, clay =15%, pH =6.6) in central Germany (MAP =618 mm, MAT =9.5°C) since **1970**.

In February 2023, we installed **rainout shelters** (2 m × 2 m) designed to **intercept 50%** of precipitation.

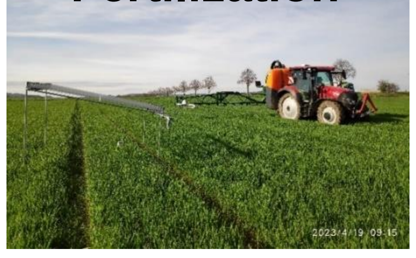
We measured **soil CO_2 efflux** & **N_2O fluxes** with static chambers and portable analyzers. Measurements occurred under Winter wheat (2022-23) and Winter barley (2023-24) cultivation.



Soil sampling

Rain-out shelter

Fertilization



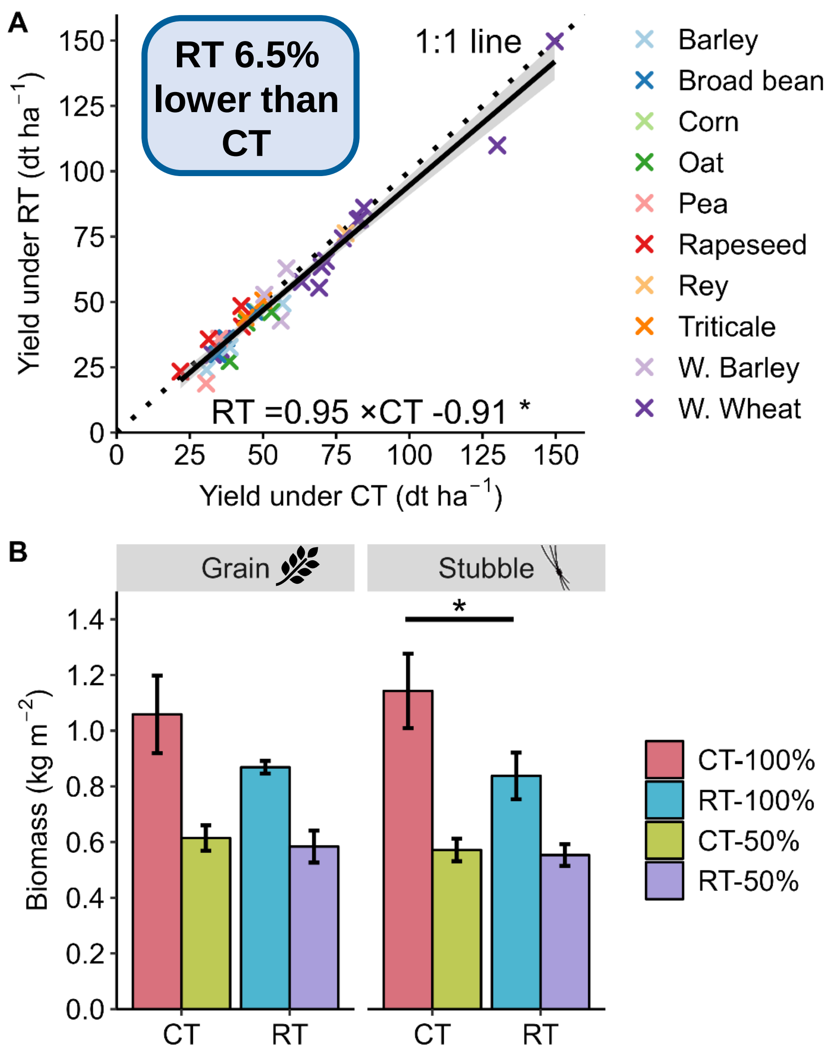


Fig 1 A Comparison between dry grain yield under Conventional (CT) and Reduced (RT) tillage since 1970 (n =35 harvests). **B** Winter wheat Grain and Stubble dry biomass under CT and RT for 100% and 50% rainfall in the cultivation period 2022-23 (n =4).

Conclusions

Reduced tillage did not lead to higher **SOC stocks** than Conventional tillage after 53 years of practice, despite lowering SOC **losses as CO_2**. In addition, it decreased **crop yield** and, under reduced rainfall, increased **N_2O** emissions.

Reduced tillage could lead to **agricultural land leakage** without increasing **SOC stocks** in temperate fine-textured soils. If **precipitation patterns** shift to drier conditions, reduced tillage might even promote **GHG emissions**.

3. Preliminary results

- **Crop yield** was 6.5% lower under RT than CT (Fig 1A)
- **Soil OC stocks** did not differ between RT & CT (Fig 2C)
- **Soil CO_2 efflux** was 24% lower under RT than CT under 100% rainfall (Fig 3D)
- **Soil N_2O flux** was 41% lower under CT than RT under 50% rainfall (Fig 3F)

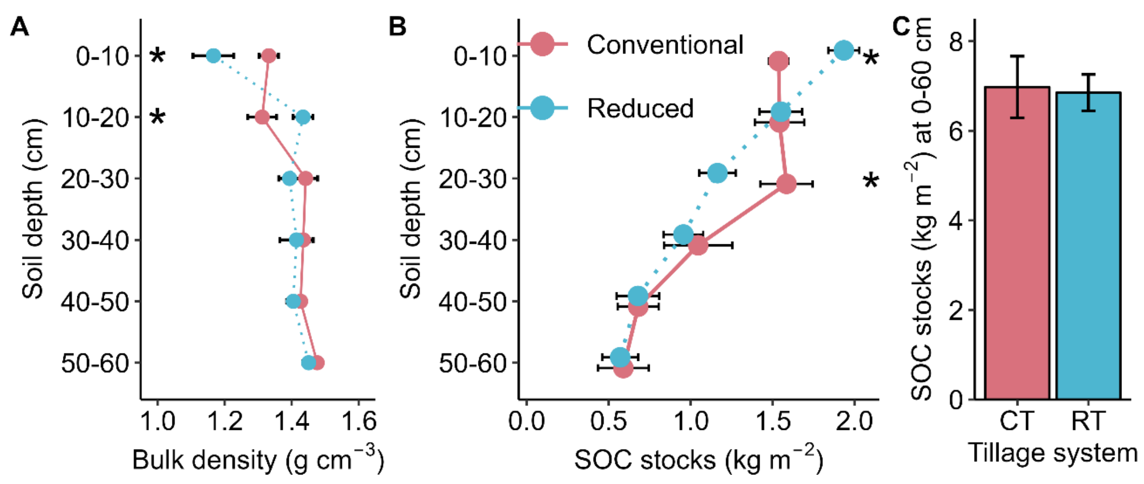


Fig 2 A Soil bulk density (2023-05-03) and **B** OC stocks at 10 cm depth intervals (2023-08-17) under Conventional and Reduced Tillage (n =8). **C** Cumulative soil OC stocks at 0-60 cm depth under CT and RT (n =8).

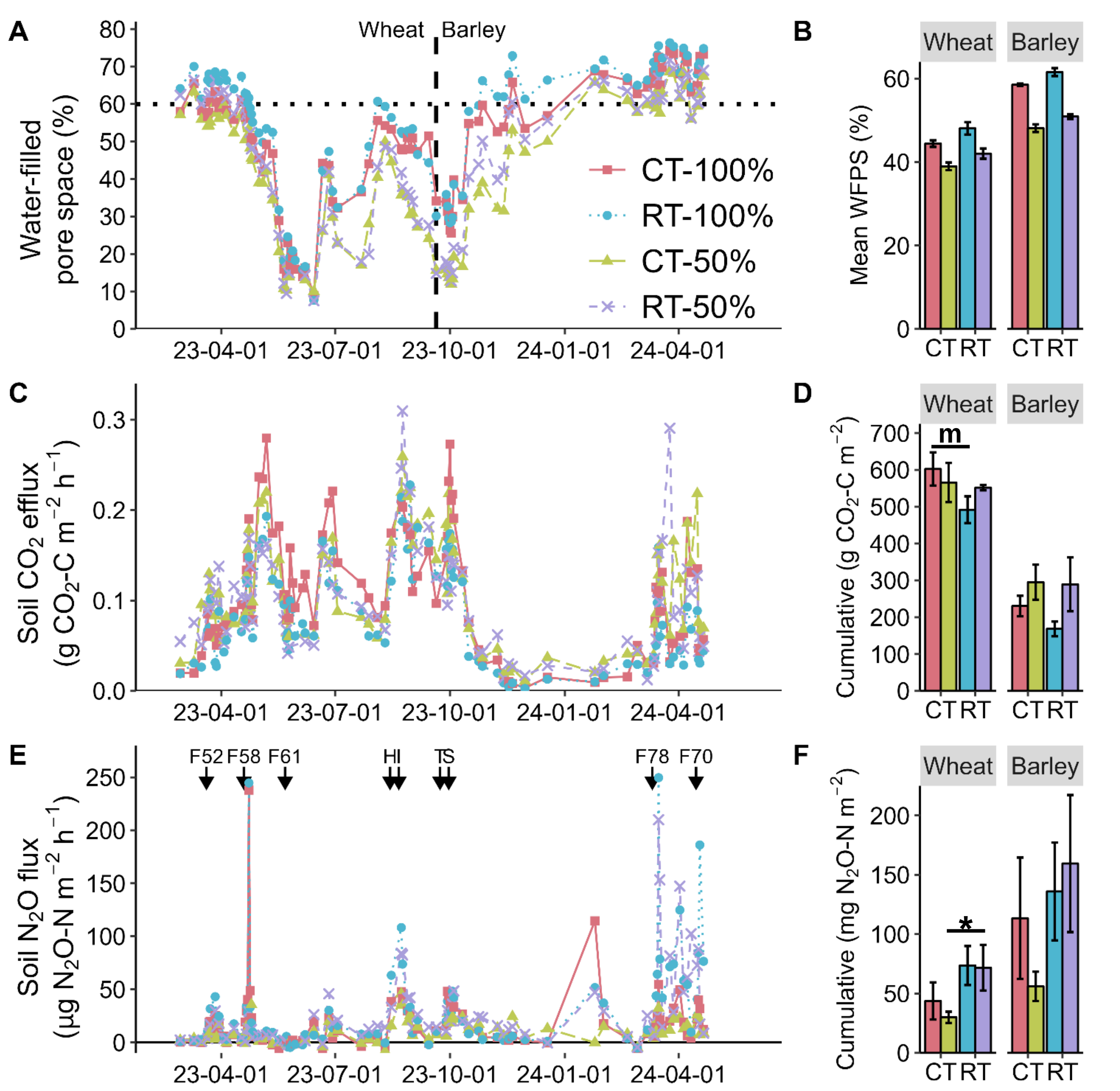


Fig 3 Water-filled pore space (WFPS), soil CO_2 efflux and soil N_2O fluxes over time (**A**, **C**, **E**) and mean WFPS (**B**) and cumulative CO_2 (**D**) and N_2O fluxes (**F**) for sample size n =4. Winter wheat **Harvest** occurred in 2023-08-14 and Winter barley **Sowing** on 2023-09-26. Dates of **Fertilization** (in kg ha^{-1}), stubble **Incorporation**, **Tillage** and **Sowing** are indicated on **E**. Asymbols * and ^{m} indicate significant and marginally significant differences.

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