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VitiSoil

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A contribution of viticulture to the climate change objectives of the Paris COP21 Conference

A comprehensive assessment of greenhouse gas emission and C & N turnover after deep soil incorporation of organic matter in vineyards

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Background and objectives

Figure 1: Potential GHG emission after deep soil organic matter incorporation

The project VitiSoil pursues the approach of using vineyard soils for additional long-term storage of atmospheric CO_2 and for mitigation of greenhouse gas (GHG) emissions. We follow the hypothesis that deep incorporation of organic matter (OM) into the subsoil will reduce the OM turnover rate and thereby increase OM stability (Fig. 1). For this purpose, two different organic materials (compost and Palaterra®) were incorporated into the subsoil of different vineyards. We quantified GHG emissions and their underlying processes by conducting both field and laboratory experiments. The ultimate goal is to determine the total GHG balance of this management option and to contribute to marketing-effective arguments on the carbon footprint of German winemaking.

Materials and methods

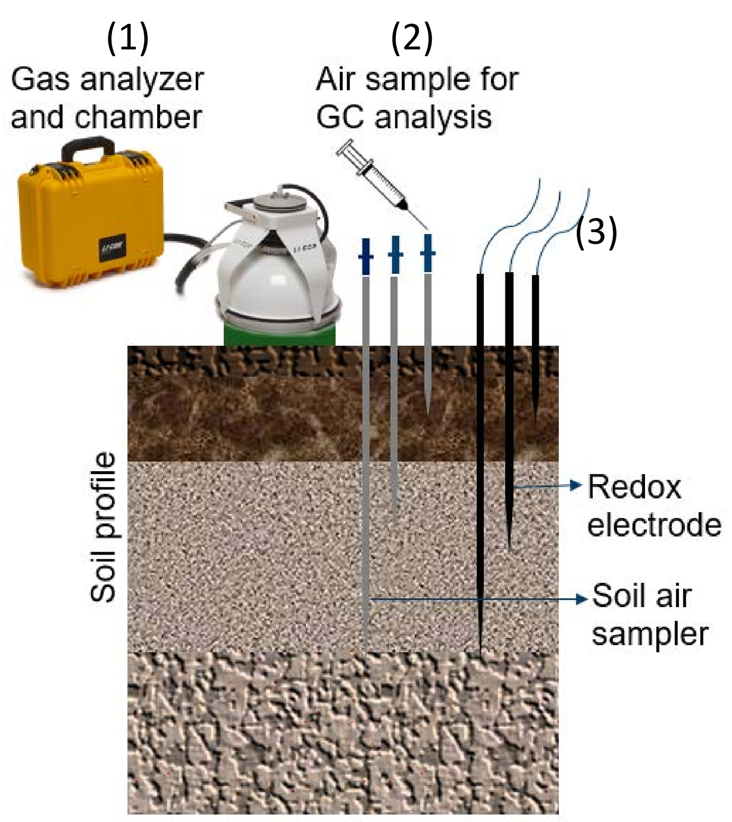

Figure 2: Field assessment of GHG

FTIR gas analyzer

Figure 3: Mobile analyzer box for field sampling

Prepared GC vials for incubation

Perkin Elmer GC

Figure 4: Analysis of GHG emission in lab incubation

Field assessment: 1. GHG flux survey (Fig. 2, 3) by using FTIR multicomponent gas analyzer and Li-Cor CO_2 analyzer. 2. Determination of GHG concentrations at 10, 30 and 50 cm soil depth by using soil air samplers and subsequent gas chromatograph (GC) analysis. 3. Soil redox potential measurements at 10, 30 and 50 cm soil depth by using Pt electrodes (Fig 2).

Lab assessment: Determination of GHG production in field-collected soil in controlled lab incubation experiments (Fig. 4).

Study area

The experimental vineyards are located in Siebeldingen (49°12′41″N,8°3′5″E) and Sprendlingen (49°51′42″N,7°59′15″E), Rhineland-Palatinate, Germany (Fig 5).

The vineyards were established in moderately sloped terrain.

Figure 5: Location of the experimental field sites

Preliminary results and discussion

- Among the measured GHGs, only CO_2 showed significant flux during the whole sampling period (Fig. 5a).
- The fluctuating emission of CO_2 over time was strongly influenced by changing weather conditions (Fig. 5b).
- GHG emission from the compost treatment was more sensitive to changes in meteorological and physical soil conditions than Palaterra®.

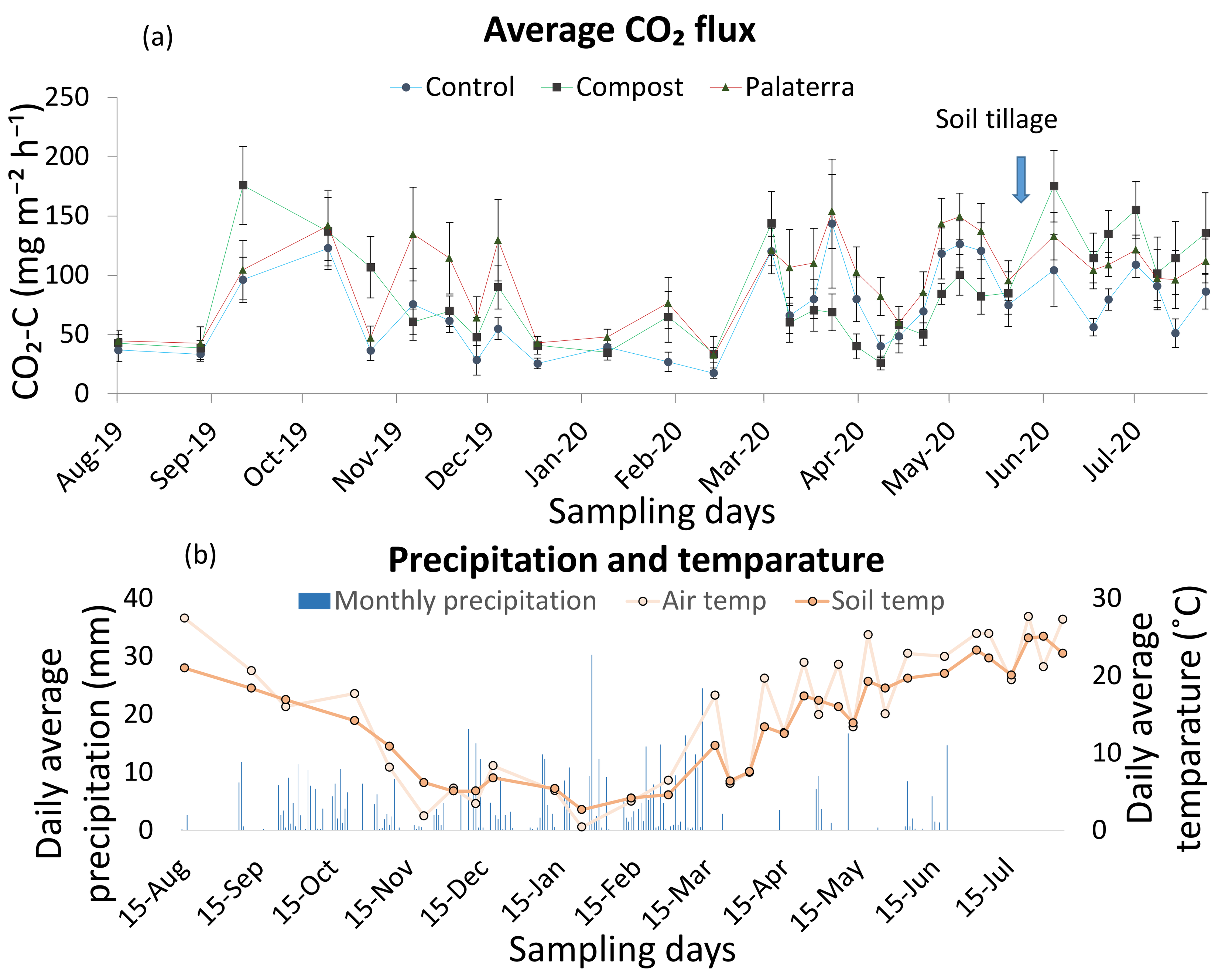

Figure 6. (a) CO_2 emission from the different treatments over time. Error bars represent ± standard error, n=8. (b) Daily average precipitation and average soil and air temperature of the sampling period.

- The cumulative CO_2 flux, measured over 1 year, was higher from the treatments than the control.
- Higher cumulative CO_2 emission from Palaterra® indicates lower stability.

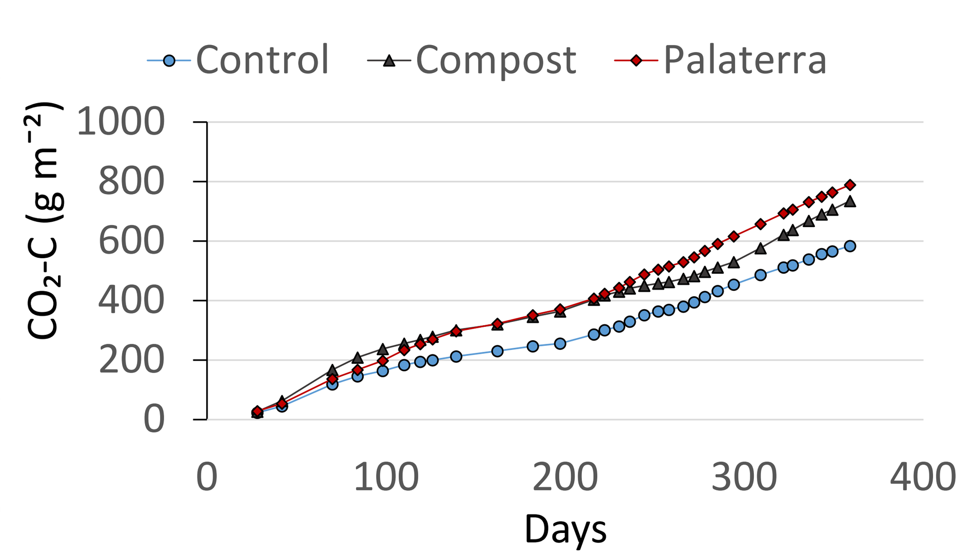

Figure 7: Cumulative CO2 flux of the different treatments over 359 days of measurement period.

- CO_2 concentration in soil pore space increased with depth.
- CO_2 concentration in treatments was higher than in the control in deeper soil layers, suggesting a higher turnover rate (Fig. 8a).
- The N_2O concentration also showed a similar increasing trend with depth.
- However, the lower N_2O concentration in the OM treatments than in the control at 50 cm suggests enhanced reduction of N_2O (Fig 8b).

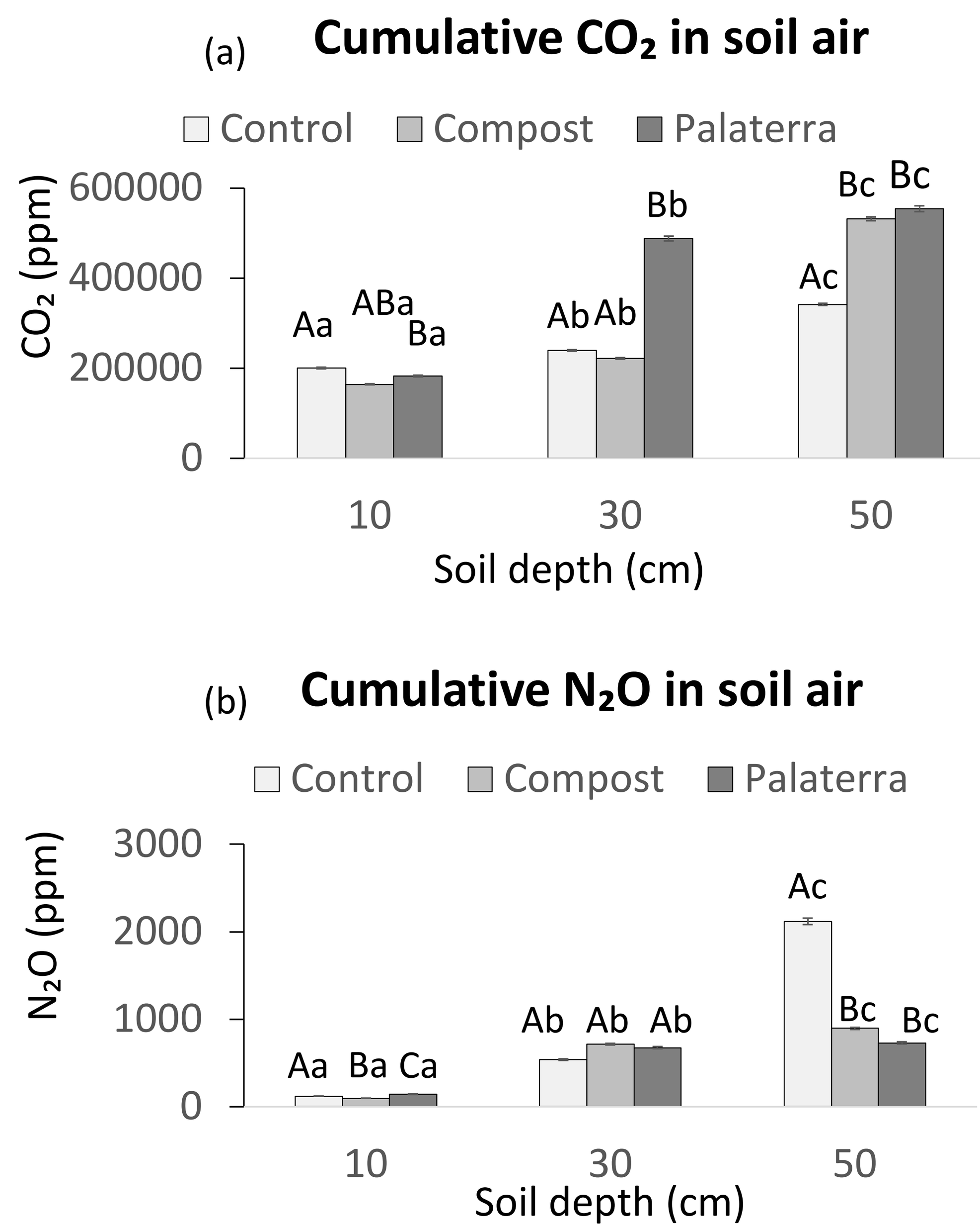

Figure 8: Cumulative CO_2 and N_2O concentration at different soil depths in different treatments over 239 days of sampling period. Error bars ± standard error, n = 18. Different latter's indicate significant differences.

Conclusion

Although the organic matter (OM) incorporation increased the overall emission of CO_2, the total C loss from compost and Palaterra® treatment after 359 days was only 14.9% and 20.13%, respectively, of the originally applied amount. This indicates that the stability of the organic matter treatments was enhanced by the deep soil incorporation.