Effect of long-term organic, inorganic and mixed fertilizer application on labile soil organic carbon fractions

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1 | Introduction

Soil organic matter contents can be strongly influenced by soil management and type of fertilizer application (Fig.1). We analyzed how different fertilization strategies influence the contents of labile soil organic carbon (LOC) and particulate organic matter (POM) after 75 years of continuous management.

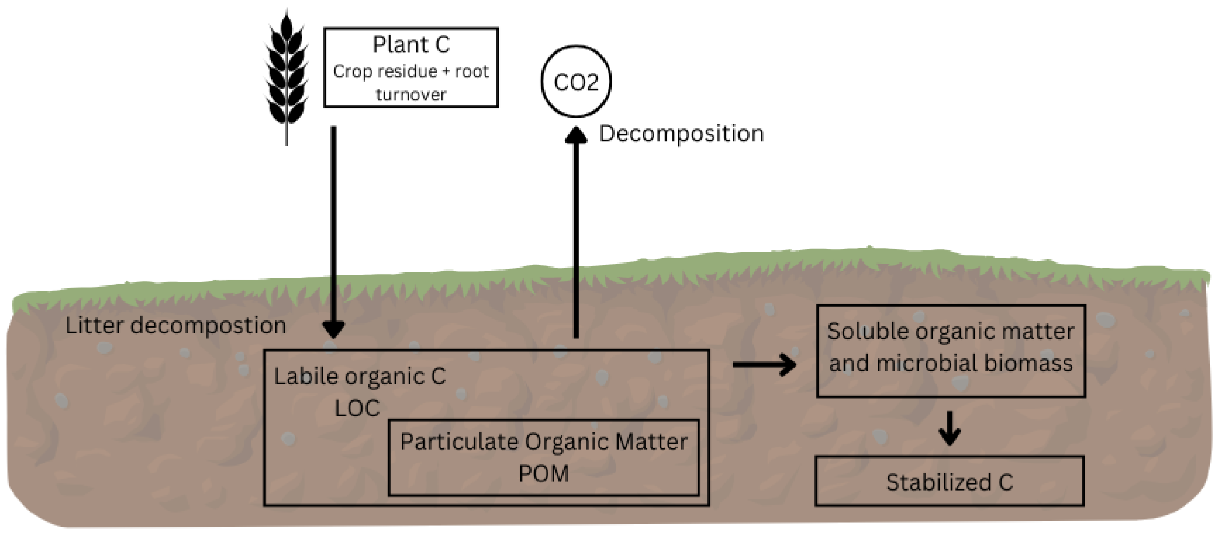

Fig. 1: Scheme of the C cycle in agricultural soils showing the relationship between various organic matter fractions (adapted from Haynes, 2005).

2 | Experimental design

The Zurich Organic Fertilization Experiment (ZOFE) field trial was established in 1949 and compares 12 different treatments of mineral and organic fertilizers alone or in combination on their effects on crop performance and soil properties. Soil samples were taken in spring 2025 in 0-20 and 30-60 cm depth. Labile carbon was determined by permanganate oxidation (Weil et al., 2003) and a physical fractionation scheme (Mirsky et al., 2008) was used to determine the POM fraction in three selected treatments.

Fig. 2. The ZOFE field trial. *Organic fertilization*: manure, compost, sewage sludge, peat. *Mineral fertilization at different intensites (0, 1, 2) for nutrients* nitrogen (N), phosphorus (P), potassium (K), and magnesium (Mg). The control treatment did not receive any fertilizer. For details consult Oberholzer et al. (2014).

4 | Conclusions

- No differences (only trends) in LOC between treatments with different organic or mineral fertilizer input levels indicate a quick turnover in the top 0-20 cm and / or unsuitability of the used method.
- Mineral fertilization slightly increased the POM fraction, yet only compost application caused a significant increase.

3 | Results

While soil organic carbon concentrations differ significantly between treatments (roughly in the order: organic fertilization > mineral fertilization > control), there was no significant different with respect to LOC (Fig. 3) in 0-20 cm. The method yielded no values for soil samples in 30-60 cm soil depth.

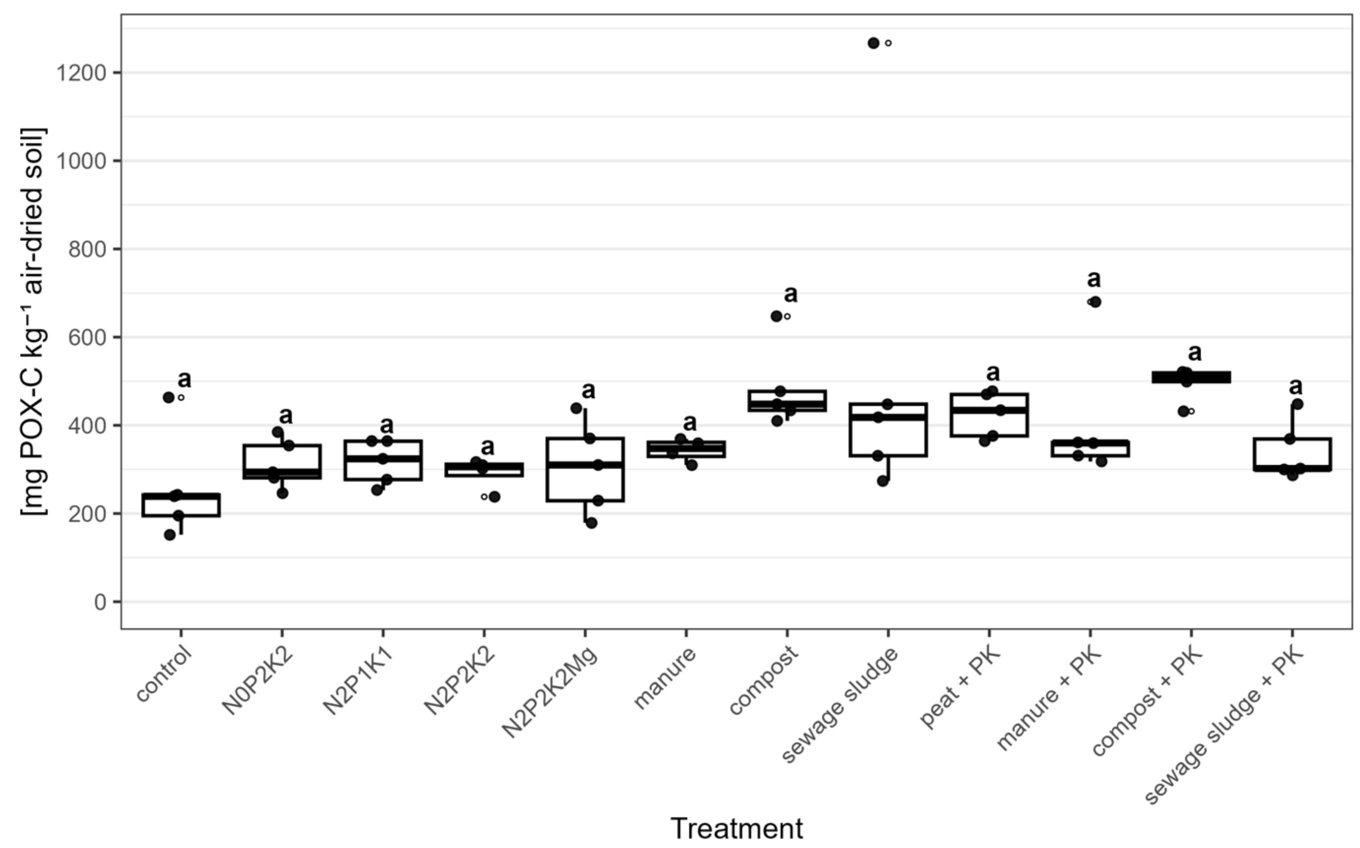

Fig. 3: Permanganate oxidizable carbon (POX-C) as indicator for labile organic carbon in the twelve treatments of the ZOFE trials. Number of replicates = 5 per treatment.

The POM concentration in the sand fractions in three contrasting treatments with different C inputs show however strong differences (Table 1), indicating a positive effect of purely mineral fertilizer but especially compost application.

Table 1: The POM fractions in three treatments that received no (Control) only mineral (NP2K2Mg) or only organic (Compost) fertlizers.

Treatments	Particulate Organic Matter in the sand fraction
Control	19 ± 4.04 g kg^{-1}
NP2K2Mg	23 ± 5.23 g kg^{-1}
Compost	33 ± 3.24 g kg^{-1}

There was a weak positive correlation between LOC and soil organic carbon (Corg), as well as with total N concentrations, calcium content and soil pH (Fig. 4).

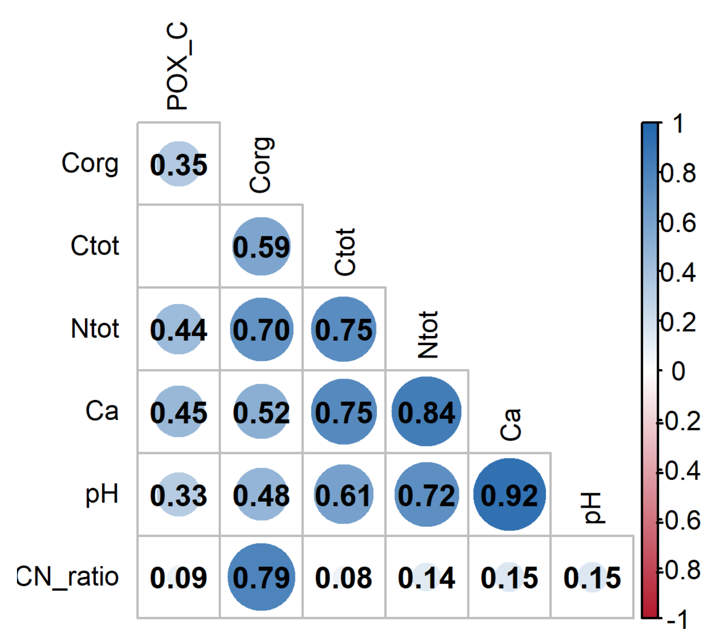

Fig. 4: Correlation matrix between key soil chemial properties among the twelve treatments in the top 0-20 cm. Abbreviations are: C/N ratio - Calculated as C/N = Corg/Ntot, Ca – Calcium AAE10, Corg - Organic Carbon, Ctot - Total Carbon, Ntot - Total Nitrogen, POX-C - Permanganate-oxidizable Carbon with Potassium Permanganate ($KMnO_4$).

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