Leibniz Centre for
Agricultural Landscape Research
(ZALF)

Mapping spatial variability of surface soil organic matter composition with a hand-held FTIR spectrometer at field scale

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Introduction

Soil organic matter (SOM) determines physical and bio-chemical soil properties and heterogeneously distributed in space especially within larger fields. SOM can be studied in the lab (mixed samples) and field (remote sensing) using Fourier Transform Infrared (FTIR) spectroscopy (Ellerbrock & Gerke, 2013). However, for intermediate scales (e.g., patches) and soil surfaces covered by plants, approaches to characterize the spatially distributed SOM are limited.

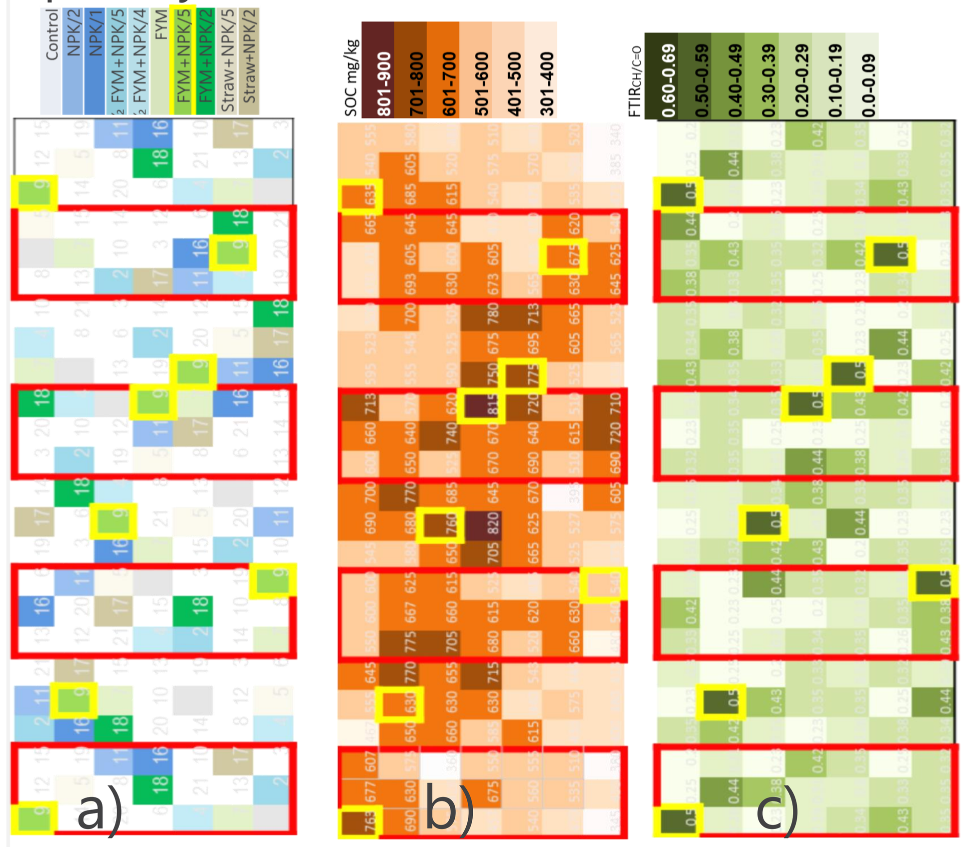

Fig. 1 a) Location, b) SOC contents and c) CH/C=O ratios in FTIR spectra of soil samples from differently fertilized plots at Müncheberg site (Ellerbrock & Grosse, 2021).

Hypothesis:

- Hand-held FTIR allow to analyze mixed soil samples as well as upper soil surface layers under field conditions (on-site).
- On-site analysis offers a possibility to study the OM composition of soil surfaces covered by plants at an intermediate plot scale allowing to determine the spatial distribution of soil properties (wettability, nutrient storage) in an experimental field.

Objectives

The objective is to test the applicability of a hand-held FTIR device. We compared the data obtained with hand-held with those of a lab-based FTIR. Can we distinguish the spatial distribution of SOM composition of topsoil samples from the patch crop plots by on-site hand-held analysis. Can these be as representative as those of lab-based spectra from mixed samples.

Material and Methods

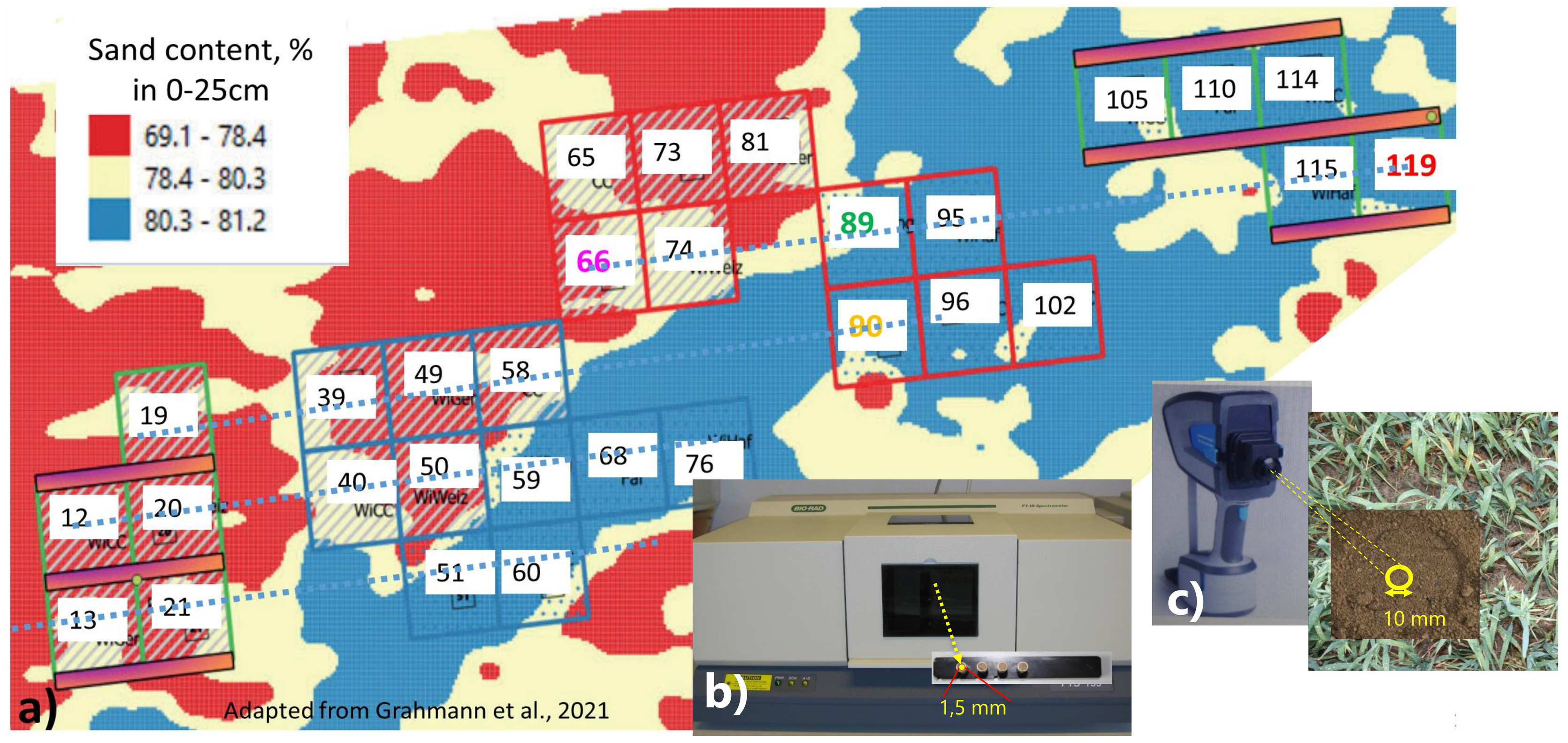

Fig. 2 a) PatchCrop site with plot location, and photos of b)lab-based (bulk soil samples in cups) and c) hand-held spectrometer (soil surface section).

Air dried bulk soil samples (0-25 cm) were analyzed using hand-held (Fig. 2b) und lab-based FTIR (Fig. 2c). Additionally sections at upper soil surface layers were analyzed on-site by hand-held FTIR (Fig. 2d).

SOM composition was determined as the ratio between the band intensities of hydrophobic (C-H), and hydrophilic (C=O) groups (C-H/C=O ratio) in FTIR spectra as a measure for the potential wettability (Ellerbrock & Gerke 2013).

Results and Discussion

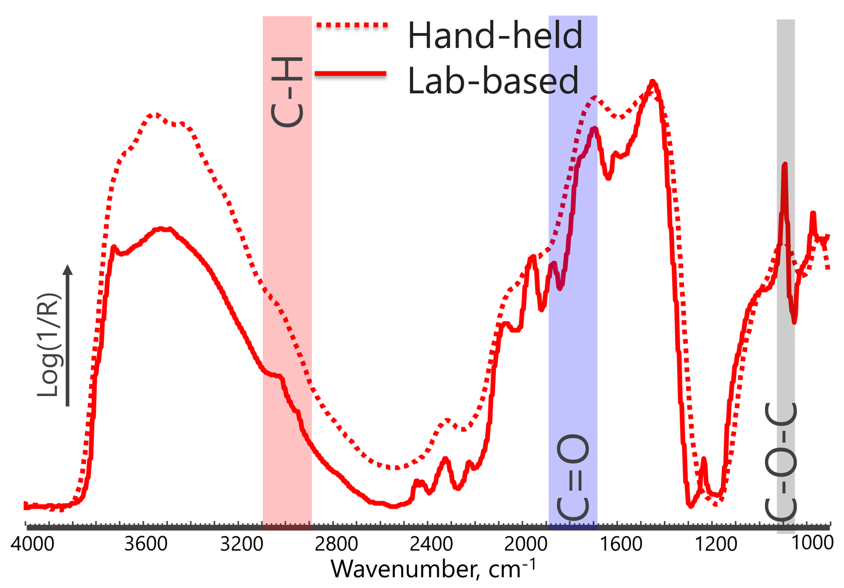

Fig. 3 Handheld and lab-based FTIR of bulk soil samples collected (plot 119).

Resolution of hand-held spectra is lower as compared to lab-based ones (Fig. 3) caused by differences in instrumental details.

C-H/C=O ratios in HH spectra are lower than those in lab-based spectra (Fig.4).

Only small variations in C=O band intensity of replicate lab-based and hand-held spectra of mixed samples and soil surface sections (Fig. 4).

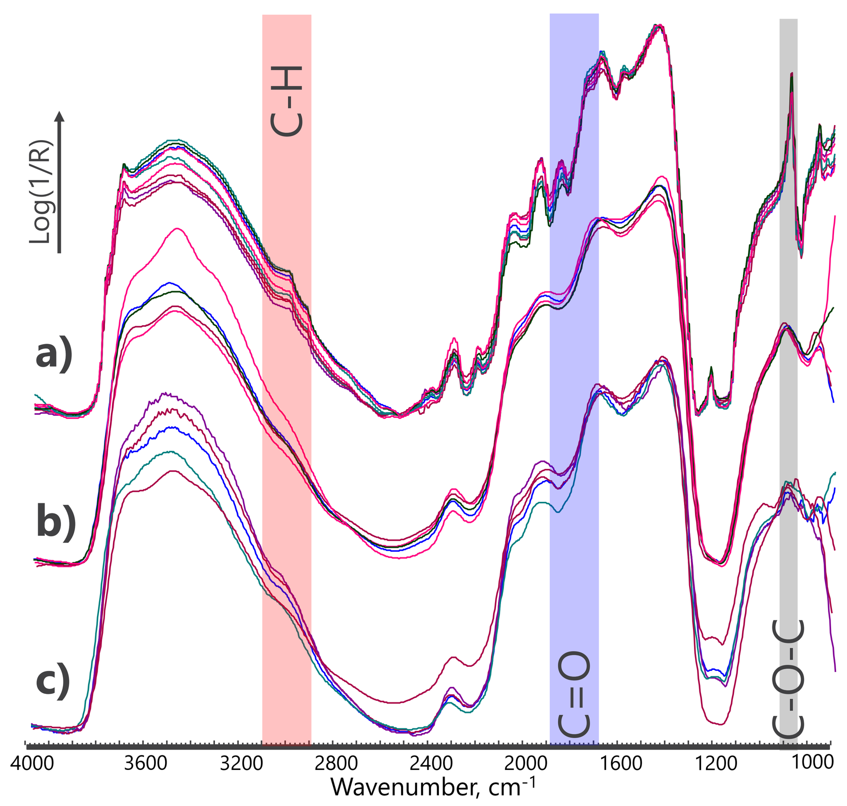

Fig. 4 a) Lab based, and b) hand-held replicate spectra of air dried bulk soil, and of replicate soil surface sections.

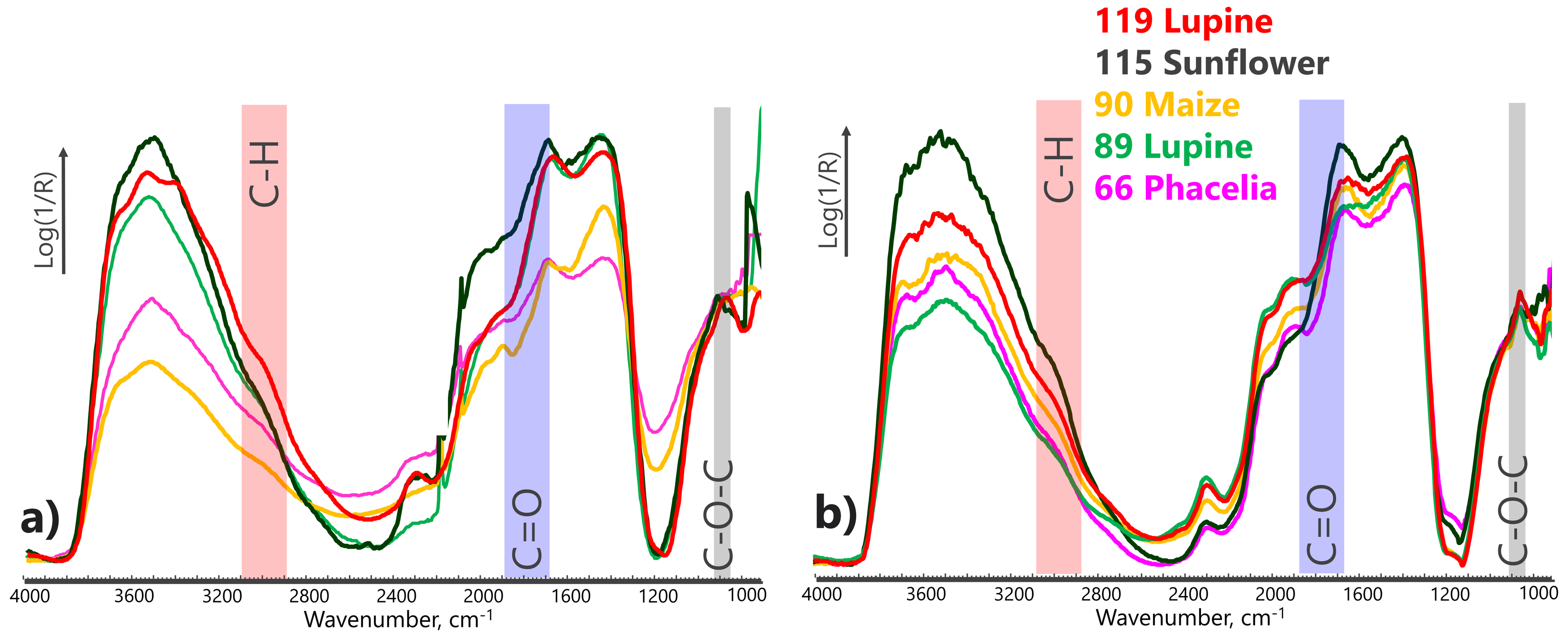

Fig. 5 Handheld Spectra of a) sections at soil surfaces (on-site) and b) of air dried bulk soils from plots 119, 115, 90, 89, and 66.

Hand-held and lab-based FTIR indicate variations in SOM composition (Fig. 5)

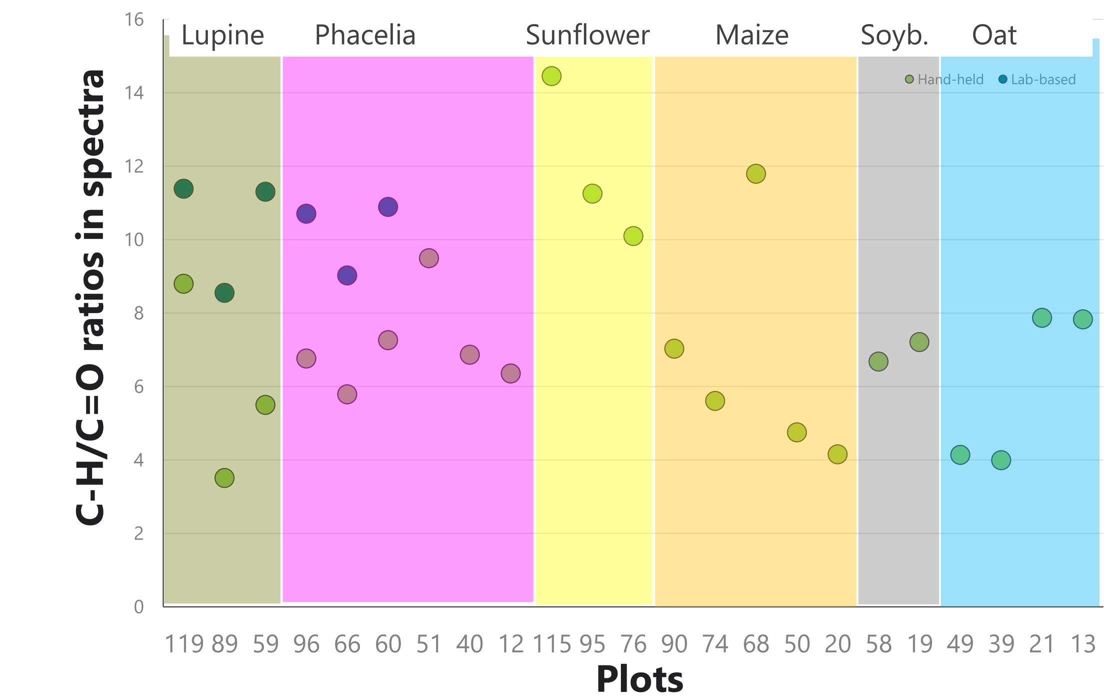

Fig. 6 CH/C=O ratio in hand-held spectra of dried bulk soils from different plots.

CH/C=O ratio are related to plot location and cropping (Fig. 6) .

For lupine the effect of plot location is stronger than cropping effect. This is much smaller for phacelia, and maize.

Summary & Conclusion

- Hand-held and lab-based FTIR are applicable to characterize spatial variability of the OM composition at the plot scale such as in the PatchCrop field experiment.
- Effects of **water** and cation (i.e. Ca, Fe; Ellerbrock & Gerke 2018) content need to be considered especially when interpreting hand-held spectra
- The mapping of near-surface SOM composition needs to be complemented by SOM depth-functions before the information can be used to improve a site-specific patch-crop management.

Acknowledgement

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References

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