THEME 2

Agricultural long-term experiments as a basis to monitor soil organic carbon

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INTRODUCTION

Agricultural long-term field experiments (LTEs) hold a key to understanding how the improved management practices such as different tillage practices, crop residue incorporation or compost amendments affect soil organic carbon (SOC). LTEs are living laboratories that enable researchers and policy-makers to gain a deeper understanding of the trends and dynamics of change, rather than a short snapshot of the situation. LTEs indeed enable the monitoring of changes in specific soil functions, such as carbon storage, which is often said to be challenging (Sachs *et al.*, 2010; Baveye *et al.*, 2016). Feasibility assessment of initiatives such as the ´4 per mille Soils for Food Security and Climate´ (Minasny *et al.*, 2017) could also benefit from LTE databases. Thus, this study was designed to investigate the long-term effects of three improved management practices in Austria, namely:

- different tillage practices (Fuchsenbigl);
- crop residue incorporation (Rutzendorf and Rottenhaus);
- compos amendments (Ritzlhof) on soil organic carbon concentrations, after 24, 30, 26, and 21 years of practice, respectively.

OBJECTIVES

The beneficial effects of minimum tillage, crop residue incorporation and compost amendment are well known (Hernanz *et al.*, 2002; D´Hose *et al.*, 2014; Lehtinen *et al.*, 2016), and our results confirm previous studies.

MAIN RESULTS

The long-term improved management practices resulted in distinctly different SOC concentrations in the different field experiments in 2012 (Table 1). In Fuchsenbigl, minimum tillage resulted in significantly higher SOC concentrations at 0-10 cm soil depth, whereas at the deeper soil depths no significant differences were observed between the management practices. This is in line with results published previously from the experiment (Spiegel *et al.*, 2007) as well as by other authors (Mrabet *et al.*, 2001).

Crop residue incorporation, in both Rutzendorf and Rottenhaus, increased the SOC concentration significantly (22.00 and 9.29 g kg^{-1}, respectively) compared to the crop residue removal treatments (20.58 and 8.43 g kg^{-1}, respectively). Similar increases in SOC concentration were also observed in Lehtinen *et al.* (2014) when data from numerous European LTEs investigating the effects of crop residue incorporation were studied.

Of the four different compost amendments in Ritzlhof, urban organic waste compost and sewage sludge compost resulted in significantly higher SOC concentrations (14.00 and 14.75 g kg^{-1}) compared to the control treatment (11.85 g kg^{-1}) that didn´t receive any fertilization.

Tab. 1: Means of soil organic carbon (SOC) in Fuchsenbigl, Rutzendorf, Rottenhaus and Ritzlhof, in 2012. Different letters indicate significant differences between the management practices at the $p < 0.05$ level, separately for each site. MT denotes minimum tillage, RT reduced tillage, CT conventional tillage, CRI crop residue incorporation, CRR crop residue removal, control no fertilisation, OWC urban organic waste compost, GWC green waste compost, MC cattle manure compost, and SSC sewage sludge compost

Tillage		Crop residue incorporation		Compost amendments	
Fuchsenbigl		Rutzendorf		Ritzlhof	
SOC (g kg^{-1})					
n = 3		n = 16		n = 4	
0-10 cm		0-25 cm		0-25 cm	
MT	20.17b	CRI	22.00b	Control	11.85a
RT	16.00a	CRR	20.58a	OWC	14.00b
CT	16.20a			GWC	13.55ab
10-20 cm		Rottenhaus		MC	12.88ab
MT	16.33a	n = 16		SSC	14.75b
RT	16.30a	0-25 cm			
CT	16.20a	CRI	9.29b		
20-30 cm		CRR	8.43a		
MT	15.40a				
RT	15.77a				
CT	16.73a				

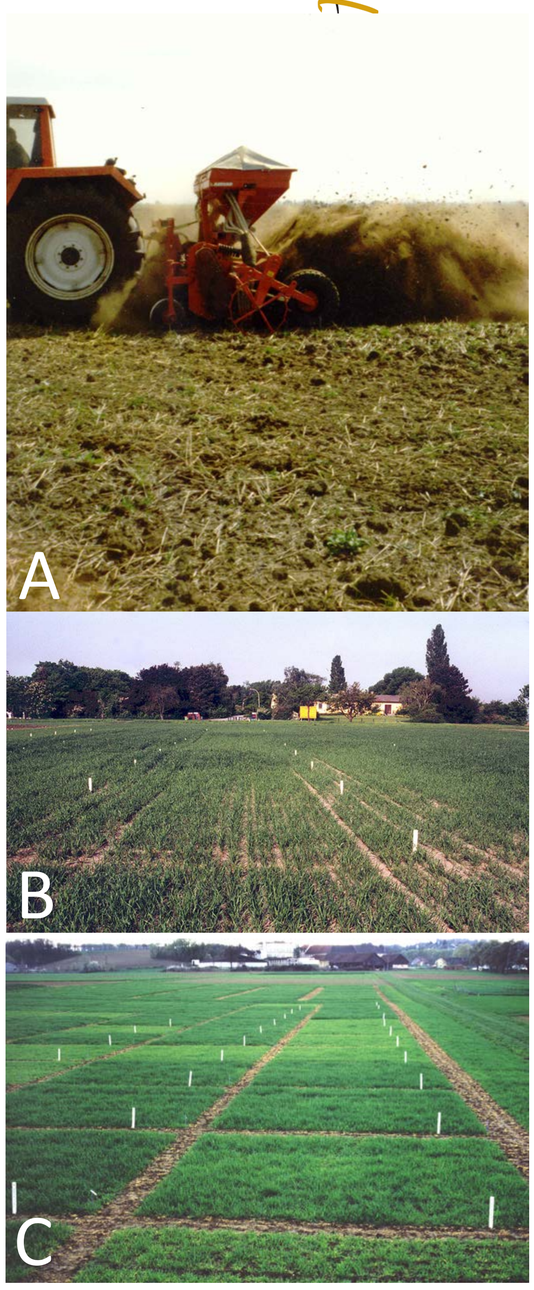

Fig. 1: The three improved management practices investigated: A) different tillage practices in Fuchsenbigl, B) crop residue incorporation in Rutzendorf and Rottenhaus, and C) compost amendments in Ritzlhof.

CONCLUSION

These four long-term field experiments demonstrate the importance of long-term monitoring sites in following the development of soil organic carbon. The beneficial effects of minimum tillage, crop residue incorporation, urban organic waste compost and sewage sludge compost were shown to increase soil organic carbon concentrations. However, monitoring of greenhouse gas emissions on the same sites would be recommended in order to further investigate the carbon sequestration potential of the selected improved management practices. We conclude that these long-term field experiments are important monitoring sites that could in the future be included in evidence-based assessment of initiatives such as the ´4 per mille Soils for Food Security and Climate´.