PO-023

Total organic carbon content and transformation of selected soil properties as affected by different farming systems

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Introduction

The maintenance of an appropriate land use system is particularly important for maintaining the productivity and carbon storage in soil. Despite this importance, current practices are only partly effective in sustainably managing organic carbon stock and protecting them from natural and anthropogenic disturbances. Land uses are closely associated not only with changes in soil organic carbon stock but also determine inputs of particular types of plants biomass (e.g. litter or fine roots).
The long-term field stationary experiment was established in autumn 1969 in Žabčice (South Moravia, Czech Republic) at the Field Experimental Station of Mendel University in Brno – see Fig. 1. The mean annual air temperature is 10.3 °C, and the mean/sum of annual precipitations are 491 mm. Generally, the experiment was established with aim to evaluate the effect of management practices - especially crop rotation system with different concentration of cereals, especially with spring barley (*Hordeum vulgare* L.); soil tillage and straw management are experimental factors. Evaluated parameters are grain yields and quality, and basic soil properties, as well.
Long-term experiment is conducted in dry and warm climate in the maize-growing region, on the heavy textured soil Gleyic Fluvisol Clayic (classified according to the IUSS Working Group WRB, 2014). Soil pH is slightly acid, humus content in the topsoil is about 2.5%, and content of available phosphorus and potassium is 80 and 198 (mg.kg^{-1}).

Fig. 1: Experimental Stationary of Mendel University in Brno (https://af.mendelu.cz/)

The aim of the study

The changes of selected soil chemical properties, especially total content of organic carbon and humic substances quality were evaluated during the period 2017 – 2020. The main goals of research were as follows:
1/ To compare the effects of factors under spring barley growing in monoculture on soil properties; monoculture = MONO (the factors - i.e. soil tillage and straw management).
2/ To compare the effects of soil tillage on soil properties under spring barley growing in crop rotation Norfolk = NF.
3/ To compare general level of parameters in different farming systems (different crop rotation).

Variants of experiment

a/ spring barley growing under monoculture (MONO): two variants of **soil tillage** (CT - conventional plough tillage to 0.22 m and MT - shallow tillage to 0.12-0.15m) and three variants of **straw management** (**SR** - straw harvested and removed, **SI** - incorporated into the soil, and **SB** – burned.
b/ spring barley growing under Norfolk crop rotation (NF): two variants of **soil tillage** (CT - conventional plough tillage to 0.22 m and MT - shallow tillage to 0.12-0.15m).
The soil samples were obtained from two field repetition due described experiments factors; in evaluation is sampling depth 0 – 0.10 m (the most important layer for information about soil organic parameters).

Analytical methods and statistical evaluation

Total organic carbon content (TOC, %) was evaluated by the oxidimetric titration method. Content of humic substances (HS, %), humic acids (HA) and fulvic acids (FA) were evaluated by the short fractionation method. The data of evaluated parameters were statistically processed by ANOVA followed post-hoc LSD test at 95 % confidence level. Statistically significant results of TOC (%) are in Tab. 1 – 4; results with quality of soil organic matter are in Tab. 5. ANOVA analysis were done with software Statistica12CZ.

Results

It was found out that agronomic factors in both types of farming led to soil aberration, which reflected a gradual decline of soil organic carbon.
1/ Results of soil parameters under monoculture
Effect of experimental factors on TOC value was statistically significant only for soil tillage variants – see Tab. 1. Higher TOC value for minimum tillage was determined. Effect of different straw management practices on TOC value was not significant and the highest value was determined with straw burning management.
2/ Results under crop rotation Norfolk
The influence of soil tillage was reflected in higher values of soil parameters with minimum tillage.
3/ Results of comparison of different crop rotation
For both crop rotation, a comparison can only be expressed for the tillage factor and the straw harvested. It can be stated that the Norfolk crop rotation has a favourable effect on the level of the monitored soil parameters; positive effect is for minimum tillage in both crop rotation.

Tab. 1 MONO - Average value of TOC [%] for tillage and level of significance

No. of factor	*Tillage*	*TOC [%]; means*	1	2
1	CT	1,089931	a	
2	MT	1,227118		b

Tab. 2 MONO - Average value of TOC [%] for straw management and level of significance

No. of factor	*Straw*	*TOC [%]; means*	1
1	Harvested	1,13401	a
2	Incorporated	1,150156	a
3	Burned	1,191406	a

Tab. 3 MONO - Average value of TOC [%] for interaction of tillage and straw management and level of significance

No. of factor	*Tillage*	*Straw*	*TOC [%]; means*	1	2	3
2	CT	Incorporated	1,031042	a		
1	CT	Harvested	1,038750	a	b	
6	MT	Burned	1,182813	a	b	c
3	CT	Burned	1,200000	a	b	c
4	MT	Harvested	1,229271		b	c
5	MT	Incorporated	1,269271			c

Tab. 4 NF - Average value of TOC [%] for tillage and level of significance

No. of factor	*Tillage*	*TOC [%]; means*	1
1	CT	1,319688	a
2	MT	1,392500	a

Conclusion

- Quality of humic substances was influenced by crop sequence, residues input, and tillage system.
- Anthropogenic influence and the intensive monoculture management leads to the negative soil aberration and has negative consequences, such as lower base saturation, decrease of pH, and lower soil carbon storage to compare to Norfolk.
- Negative aberration requires some agro technical measures, organic fertilizers application and liming.

Tab. 5 Average values of determined chemical parameters
(where: MONO–SH–CT = monoculture–straw harvested–conventional tillage;
MONO–SI–CT = monoculture–straw incorporated–conventional tillage;
MONO–SB–CT= monoculture–straw burned–conventional tillage;
MONO–SH–MT = monoculture–straw harvested–minimum tillage;
MONO–SI–MT = monoculture–straw incorporated–minimum tillage;
MONO–SB–MT = monoculture–straw burned–minimum tillage;
NF–CT = Norfolk–conventional tillage;
NF–MINIM = Norfolk–minimum tillage).

Tab. 5 Average values of determined chemical parameters

Variants/Parameters	*TOC [%]*	*HS [%]*	*HA [%]*	*FA [%]*	*HA/FA*	*DH [%]*
MONO - SH - CT	1,04 very low	0,40 medium	0,20 medium	0,20 medium	1,04 medium	19,83 medium
MONO - SI - CT	1,03 very low	0,46 medium	0,22 medium	0,24 medium	0,98 medium	21,55 medium
MONO - SB - CT	1,20 low	0,47 medium	0,24 medium	0,22 medium	1,12 medium	20,66 medium
MONO - SH - MT	1,23 low	0,46 medium	0,23 medium	0,24 medium	1,01 medium	18,97 medium
MONO - SI - MT	1,27 low	0,50 medium	0,26 medium	0,25 medium	1,04 medium	20,15 medium
MONO - MT	1,18 very low	0,44 medium	0,23 medium	0,21 medium	1,08 medium	19,09 medium
NF - CT	1,32 low	0,53 medium	0,27 medium	0,22 medium	1,24 medium	20,40 medium

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Keywords

- Long-term field experiment
- Monoculture of spring barley
- Norfolk crop rotation sequence
- Soil tillage
- Straw management
- Organic carbon content and parameters of soil quality

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