Comparison of soil CO_2 emissions from three different tillage methods on chernozem soil

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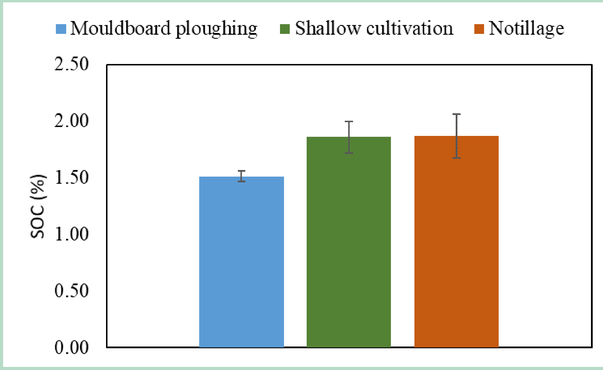
Abstract

In this study we investigated the soil CO_2 emission of a conventional (mouldboard ploughing, 28-30 cm tillage depth) and two conservational (shallow cultivation, 18-20 cm tillage depth and notillage, 0 cm tillage depth) tillage treatments of a long-term experiment operating since 2002.
The aim of this study was to examine the differences between soil CO_2 emission of conventional and conservational tillage techniques and determine the main environmental drivers.

Methods

We investigated the soil CO_2 emission of mouldboard ploughing, shallow cultivation and notillage in Józsefmajor Experimental and Training Farm, Hungary (MATE University, Gödöllő) on a calcic chernozem under winter oat cropping in 2020.
We measured CO_2 emissions in 7 replicates/treatment with EGM-5 IR-analyzer (PPSystems, USA). Measurement time was 2 minutes at each sampling points.
We measured soil temperature and soil water content near every CO_2 sampling points with Hydrosense 2 soil moisture probe (Campbell Scientific, USA) and a soil thermometer (PPSystems, USA).
We determined soil organic carbon content (SOC) with wet chemical analysis in 3 replicates/treatment during spring and fall.

Fig 2. Soil organic carbon (SOC) content in mouldboard ploughing, shallow cultivation and notillage treatments



In 2020, soils under conservational tillage techniques had higher SOC content than soil under mouldboard ploughing technique

Findings

Fig 1. CO_2 emission of soils under mouldboard ploughing, shallow cultivation and notillage techniques and mean soil temperature (harvest and tillage are indicated with dashed lines

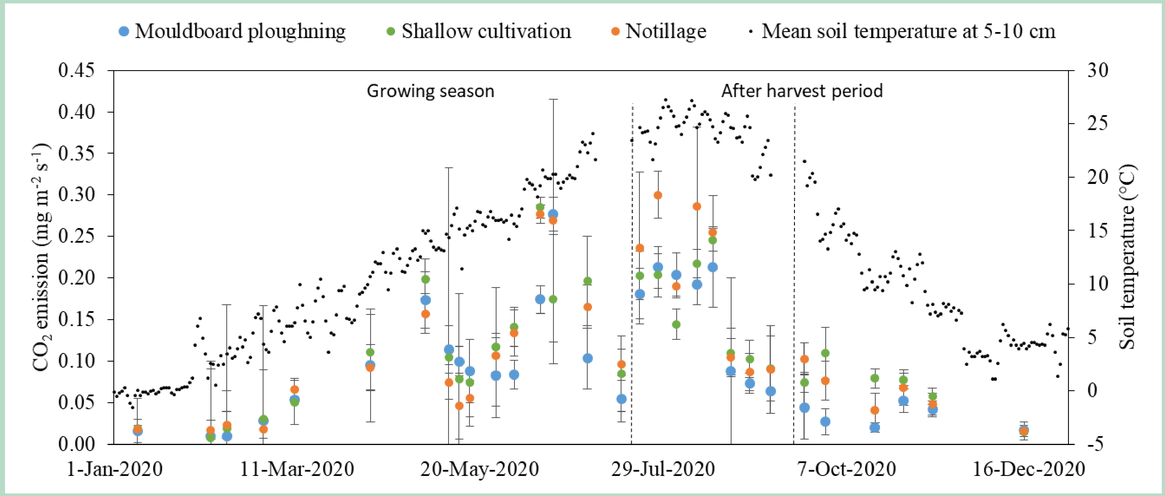


Table 1. Mean soil CO_2 emission of the different treatments over time (a,b indicate significant differences)

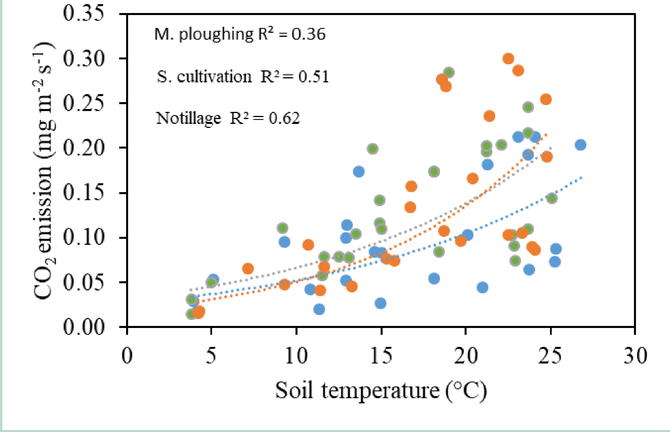
	CO_2 emission of soil (mg m^{-2} s^{-1})		
Treatment	S. cultivation	Notillage	M. ploughing
Whole year	0.115 ± 0.083^{a}	$0.119\pm0.100^{a,b}$	0.099 ± 0.089^{b}
Growing season	0.106 ± 0.088^{a}	0.104 ± 0.088^{a}	0.096 ± 0.090^{a}
After harvest	0.136 ± 0.109^{a}	0.124 ± 0.76^{a}	0.102 ± 0.088^{b}
After tillage	0.069 ± 0.038^{a}	0.059 ± 0.033^{a}	0.034 ± 0.027^{b}

Conclusions

- **Vegetation had a balancing effect on soil CO_2 emissions of the different tillage treatments during the growing season**
- **Higher soil organic carbon content might be responsibe for the higher soil CO_2 emissions in the case of conservational tillage methods after harvest**

- There was significant difference ($p<0.05$) between the mean soil CO_2 emissions of shallow cultivation and mouldboard ploughing during the whole year, higher emission occured in shallow cultivation
- No differences were found ($p>0.05$) between the treatments during the growing season
- Both of the conservational treatments had significantly higher ($p<0.05$) soil CO_2 emissions than the mouldboard ploughing during the after harvest and the after tillage periods

Fig 3. Temperature dependency of soil CO_2 emission (r^2 are included)



- Soil CO_2 emission had a non linear correlation with soil temperature
- Soil CO_2 emission under conventional tillage had week correlation (r^2=0.36) on soil temperature
- Soil CO_2 emission under conservational tillages had moderate correlation (r^2=0.51-0.62) on soil temperature
- Soil CO_2 emission had weak to no correlation (r^2=0.01-0.15) with soil water content during experimental time (not shown in figure)

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