Long-term crop rotation and fertilisation effect on soil organic matter dynamics in sustainable agriculture management systems

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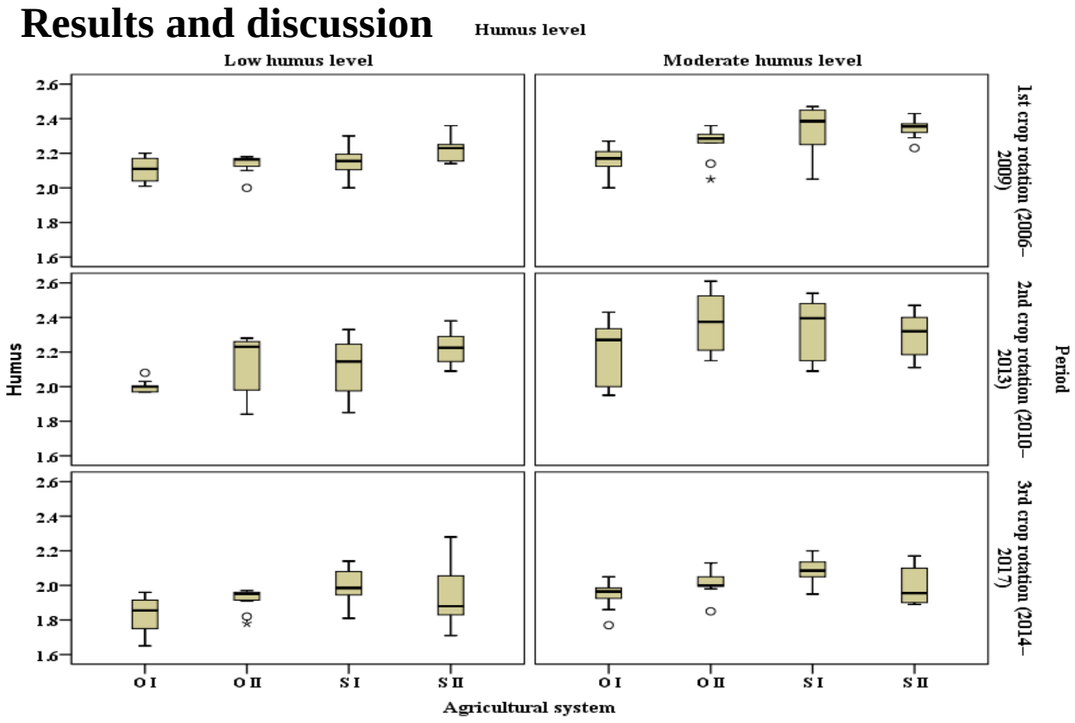
Introduction. One of the most important indicators of soil fertility is the soil organic matter and/or humus content. Humus content has the greatest importance for plant nutrition with nitrogen, as it supplies most of the crop nitrogen uptake. In many countries, fertilisation recommendations are based on the balance approach, taking into account the nutrient demands of the planned crop yield and the agro-chemical properties of the soil.

Materials and methods

The objective of this research was to determine the impact of long-term crop rotation and organic and mineral fertilisation on soil humus content, humic and fulvic acids, organic matter humification in organic and sustainable agricultural management systems with low (1.90–2.01 %) and medium (2.10–2.40 %) humus levels. . Results of the long-term use of organic and sustainable agricultural management systems with different crop rotations and fertilisation revealed the positive effect of the applied agro-means on soil humus, especially that of farmyard manure in combination with green manure.

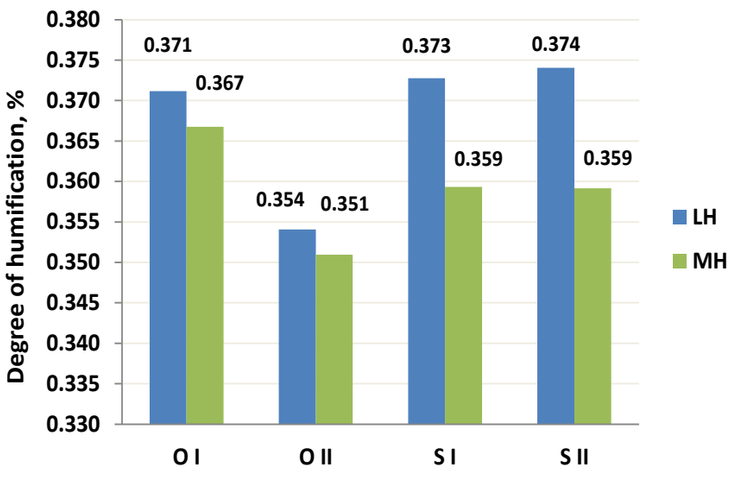
Agricultural system	Crop rotation fertilisation	
	before winter wheat	after winter wheat
organic I (OI)	aftermath of perennial grass	narrow-leaved lupine in mixture with oil radish
organic II (OII)	farmyard manure 40 Mg ha^{-1} + aftermath of perennial grass	white mustard
sustainable I (SI)	farmyard manure 40 Mg ha^{-1}	white mustard in mixture with common buckwheat + mineral N fertiliser (N_{30}) for straw decomposition
sustainable II (SII)	aftermath of perennial grass	mineral N fertiliser (N_{30}) for straw decomposition (without catch crops)

Results and discussion



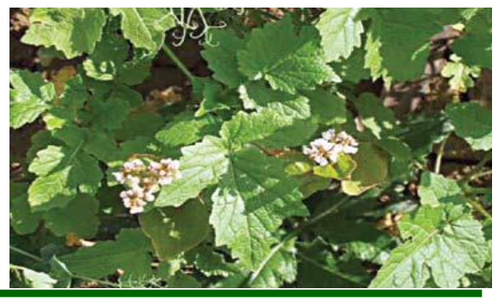
Impact of systems of agriculture on soil humus content (%) and its variations.

Note: OI – Organic I, OII – Organic II, SI – Sustainable I, SII – Sustainable II. LH – low humus level (1.90–2.01 %), MH – moderate humus level (2.10–2.40 %). Periods: 2 – after the 1st crop rotation (2006–2009), 3 – after the 2nd crop rotation (2010–2013), 4 – after the 3rd crop rotation (2014–2017).



Degree of organic matter humification in different systems of agriculture.

Note: OI – Organic I, OII – Organic II, SI – Sustainable I, SII – Sustainable II. LH – low humus level (1.90–2.01 %), MH – moderate humus level (2.10–2.40 %). No asterisk means no statistically significant differences.



Conclusions:

After the first crop rotation, it was concluded that the alternative systems of agriculture, fertilisation and catch crops had positive influences on humus content in the soils with low and moderate humus levels. After the second crop rotation, the used agricultural means appeared not to have been enough to maintain the humus content, making it to decrease by 0.06 to 0.42% during. The humus content in soil with low humus levels before the start of the experiment did not correlate with the humus content determined after the 2nd crop rotation, but the humus content in soil with moderate humus levels showed a moderate but significant correlation with the content prior to the start of the experiment. After the third crop rotation, the effect of agricultural means used in the crop rotation was revealed, especially combination of farmyard manure with green manure. Organic matter decomposition in organic II and sustainable I systems of agriculture was more humic and a significant increase in humus content was found in soils with both low and moderate humus levels. It was shown that the humus content in the soil with low humus levels prior to the start of the experiment was significantly correlated with the humus content determined after the third crop rotation, but there was no significant correlation in the soil with moderate humus levels.

Mineral fertilisers used in sustainable system of agriculture II were not effective compared to the use of organic fertilisers, however, the soil was distinguished by higher organic carbon content in the first and second HA fractions compared to organic system I. The increase in the humic and fulvic acids ratio was established, which in many cases was caused by the application of manure for winter wheat fertilisation in organic II and sustainable I systems of agriculture. The humus in soils with low and moderate humus levels was of the humatic type under all systems of agriculture, but it changed into humic-fulvic type in soil with low humus levels under organic system II and in soil with moderate humus levels under organic system I.

Different forms of organic fertilisers are the main sustainable technology that should be integrated with other agricultural practices in order to make alternative systems of agriculture more productive and efficient, and less negative to the environment.