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CARBON SATURATION POTENTIAL IN LONG-TERM WINTER WHEAT CROPPING SYSTEMS ON CHERNOZEM

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INTRODUCTION

Sequestration of atmospheric carbon (C) in soils is considered an important tool in CO_2 mitigation, therefore various management options for increasing soil organic carbon (SOC) have been discussed. Agricultural soils are usually characterized with high C sequestration potential, but promising management strategies are slowly accepted. Several studies showed that there is an upper limit of SOC storage that represents C saturation at a specific level where soil losing its ability to stabilize soil organic matter against microbial mineralization. Conversely, C saturation indicated historical loss of SOC in soils under specific management practices. Therefore the aim of this study was to evaluate C saturation potential under different management practices in winter wheat production system on Chernozem.

MATERIALS AND METHODS

To evaluate C saturation, the data was acquired from the long-term experiment on a Haplic Chernozem at the Rimski Šančevi experimental station of the Institute of Field and Vegetable crops. Soil samples were collected from the winter wheat and adjacent land (control) for 0-20 cm and 20-40 cm depth under the following treatments: 4-year rotation with manure 40 t ha^{-1} (BØ); 4-year rotation, manure 40 t ha^{-1}+100 kg N ha^{-1} (B2); 4-year rotation 200 kg N ha^{-1} without crop residues (A4); 4-year rotation 200 kg N ha^{-1} + crop residues incorporation (C4); wheat monoculture + 100 kg N ha^{-1} (MO); 2-year rotation + 100 kg N ha^{-1} (D2); 3-year rotation + 100 kg N ha^{-1} (D3); unfertilized 2-year (N2); 3-year rotation (N3) and native vegetation (NV). The potential C saturation (C_{satpot}) of particles <20 µm was calculated using the equation of Hassink (1997) C_{satpot} =4.09 x 0.37 x ≤µm particles (%). To calculate the C saturation deficit (C_{satdef}) measured C concentrations of the fine fraction were subtracted from the potential C saturation. The total amount of the C sequestration potential was calculated using the Weismeier et al. (2014) equation $C_{seq}=C_{satdef}$ x BD x depth x 10^{-2}.

RESULTS AND DISCUSSION

In the topsoil C_{satdef} was lower at unfertilized 2-year rotation and higher at 4-year rotation with crop residue removal (Fig.1). This can be explain with the historic C loss at N2 and mineral association protection of SOC against microbial mineralization, while lack of available C limited its saturation potential in A4. An average C sequestration in 0-20 cm soil depth was 2.78 kg m^{-2} being higher at D3 and lower at B2. In the 20-40 cm soil depth average C_{seq} was higher compared to topsoil (3.02 kg m^{-2}) indicating the higher potential for SOC storage and preservation and faster loss of C in topsoil (Fig. 2). Compared with arable land, control (native vegetation) has no advantage in C sequestration potential. The ratio of bulk SOC in C_{satpot} averages at 61.48 % and 57.04% for the 0-20 cm and 20-40 cm, respectively. Also our results showed that topsoil has a higher capacity to increase the SOC compared to deeper depth (Fig. 3). This showed the capacity of (possibility), approximately, 40% increase in SOC of Chernozem with using carbon smart agriculture systems in the future. Presented results are partially a consequence of soil texture differences that can be also attributed to a long-term soil management practices.

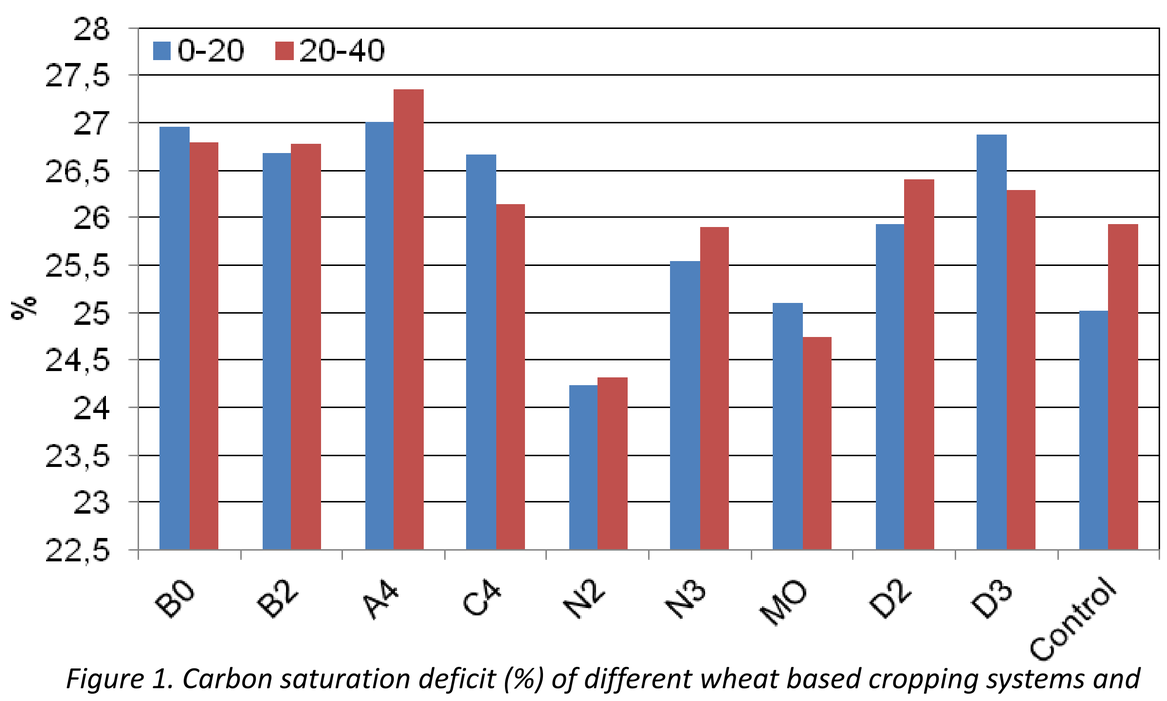

Figure 1. Carbon saturation deficit (%) of different wheat based cropping systems and control (natural vegetation)

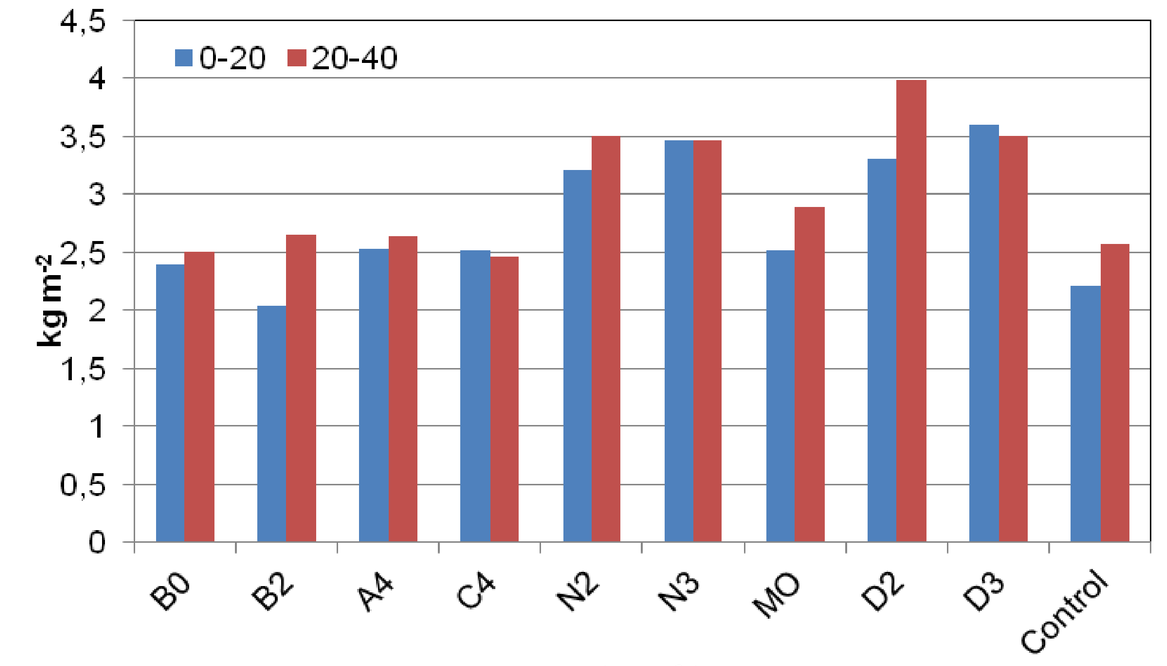

Figure 2. Carbon sequestration potential (kg m^{-2}) of wheat based cropping systems and control (natural vegetation)

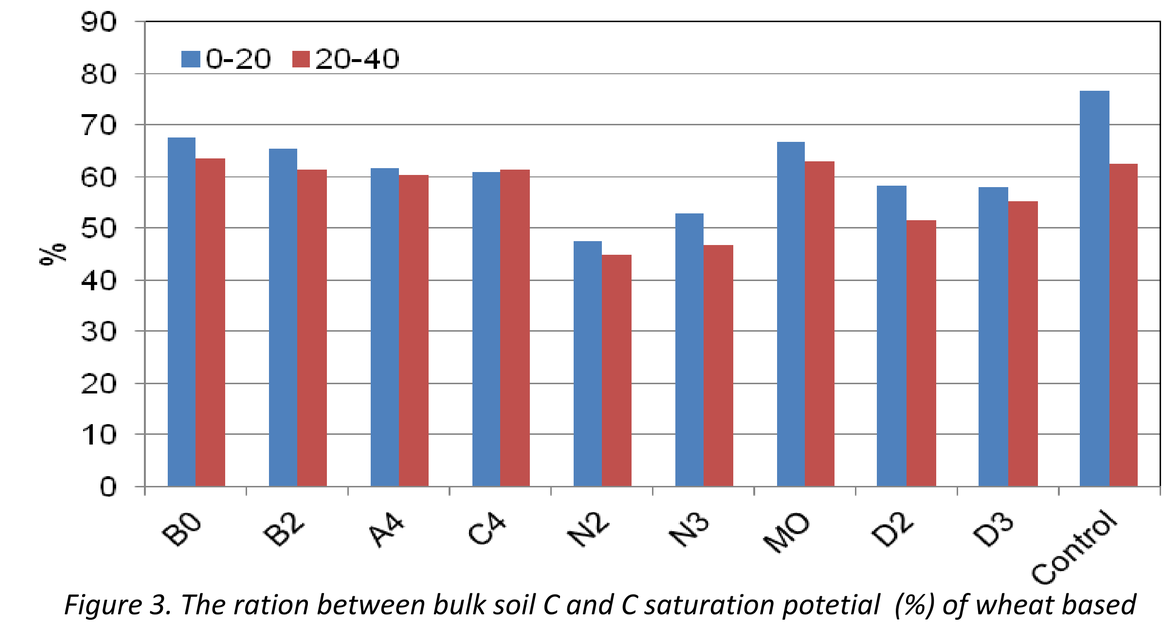

Figure 3. The ration between bulk soil C and C saturation potetial (%) of wheat based cropping systems and control (natural vegetation)

CONCLUSIONS

Our study showed C sequestration potential of average 2.9 kg m^{-2} and loss of 40% of SOC in Chernozem soil. The improvement in SOC is more efficient in soil with lower SOC content compared to higher ones. The obtained result could have implications in adopting "4 per Mille" (4p1000) strategy that suggested that an increase of 0.4% yr^{-1} in SOC stock.

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