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# SOIL ORGANIC MATTER POOLS AND AGGREGATE FRACTIONS IN ORGANIC AND CONVENTIONAL WINTER WHEAT CROPPING IN VOJVODINA PROVINCE OF SERBIA

## SUMMARY

There is a lack of information on differences between organic and conventional soil management practices effects on the soil organic matter and aggregate fractions. Therefore, our research aimed to investigate those land-use systems to better understand the relationship between soil organic carbon (SOC) and soil structural properties in field crops production. For the purpose of this study, six locations under winter wheat, representing Haplic Chernozem soil type, were surveyed at 0-30 cm depth. On average, the distribution of soil aggregate fractions and soil organic matter (SOM) content was comparable in organic and conventional farms. Higher content of total and labile SOC was obtained from >2000 μm fraction being most important fraction in the turnover of soil organic matter. The degree of C saturation turned out to be an important regulator of SOC stability and turnover rates while carbon sequestration rate (2.64-2.84 kg $m^{-2}$) indicated the high potential of C increase in Chernozem soil. Detection of soil quality improvement in organic farming systems requires a longer period of time due to changes in utilization and a management practices. Direct links between labile carbon and soil physical condition are being pursued to help organic farmers manage soil resources more efficiently.

**Keywords:** land-use systems, fraction, total and label SOC

## INTRODUCTION

Increasing demand for healthy food in the Republic of Serbia led to the conversion of conventional farms to organic, which could help facilitate soil

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quality preservation and environmental protection in agriculture. Properly designed tillage methods, fertilization, selection of varieties and balanced plant and animal production can exert significant effects on over all sustainability of the farms that can be a pillar in redesigning food systems to maximize ecological, economic, and social co-benefits (Kovačević and Dolijanović, 2017). Winter cereals under certified organic agriculture occupy the largest area, therefore, improving their production method could have a significant impact on the organic farming expansion (Šeremešić *et al*., 2019). So far, more attention in organic production was given to the yield and economic performance of crops and less to soil improvement. As a result, in the agroecological conditions of Vojvodina, there is not sufficient research on the impact of sustainable land-use systems on soil OM changes. Therefore, soil resilience and protection in the organic plant production remains a challenge.

Given that organic cropping is intended to enhance soil performance by adjusting the relationship of soil organic matter (SOM) and soil physical properties, long-term research should be performed to better understand this process. According to Bronick and Lal (2005) developments of soil structure depends on the soil aggregation processes and mediates many physical soil functions and gives us the understanding of the carbon turnover and distribution in relation to applied management practices. At the same time, the level of total OM changes relatively slowly and the negative consequences on yield become noticeable only when the level of OM falls below 2% (Oldfield *et al*., 2019), which can result in an irreversible process of degradation of all soil properties and complete loss of productivity. However, total OM pool is not sufficiently precise in monitoring changes caused by land use because of slower turnover rate. Therefore, quantification of the labile SOM fraction could be better indicator because it is directly controlled by management practices. Since the SOM is a major pool of soil organic carbon (SOC), sensitive to changes in climate or local environment (Schmidt *et al.,* 2011), investigation of fractions that is most prone to land-use changes are required (Ćirić, 2016). Labile SOC, such as hot water extractable organic carbon (HWOC) can be used as sensitive indicators of SOC change (Ghani *et al*., 2003), as well as indicators of anthropogenic impacts to ecosystems (Ćirić, 2016). Fractions characterized as HWOC are free, easily mineralizing organic substances that pass through a 0.45 μm filter and consist mainly of carbohydrates derived from plant roots, microorganisms, amino acids, humic substances and to a lesser extent monomers of phenol and lignin, proteins and chitin (Leinweber *et al*., 1995). The high level of biodegradability of the HWOC fraction affects soil $CO_2$ (Kim *et al*. 2012), as a result of which this fraction has a significant impact on the global carbon cycle and the effects of climate change. The HWOC fraction is the most active SOM compound, particularly sensitive to management practices and closely involved in aggregation and aggregate stability.

Since management strategy in organic agriculture relies upon fostering natural processes in soil, we anticipate that the labile SOM pool is a valuable indicator of favorable management. It is well known that soil organic matter declines with tillage, insufficient fertilization, and removal or burning of crop residues (Šeremešić *et al*., 2013). Also, it is considered that the loss of organic matter (OM) in the soil is one of the most pronounced consequences of intensive agricultural production (Bai *et al*., 2018). On the other hand, modern understandings of the role of soil in sustainable agriculture start from the harmonization of production with natural fertility and soil quality (Ćirić *et al*., 2014). Since the persistence of soil organic carbon is primarily an ecosystem property (Schmidt *et al*., 2011), this study aimed to access the effects of these two management practices on SOM stabilization and aggregate fraction distribution. We expect, as soil management practices differ in these two types of systems, that organic farming systems can preserve the SOM pool in all of its fractions. Nevertheless, there is no universal solution to the selection of management practices that favor soil structure stabilization and organic matter preservation. Though, an individual approach is required for each farm to assure proper selection of agro-biological measures suitable for pedo-climatic conditions. Therefore, the aim of this study was to investigate differences between organic and conventional land-use systems to better understand the relationship between soil organic carbon (SOC) and structural properties in field crops production.

## MATERIAL AND METHODS

Our study encompasses six different locations in Vojvodina Province of Serbia on in a temperate climatic condition. Soil samples were obtained from organic and conventional land use systems from the plots where winter wheat was grown. The criteria for the organic farms were that at least 5 years they have been certified as fully organic production. Sampling was performed in April and May, simultaneously at organic and conventional systems before winter wheat harvest. Three composite soil samples per plot, representing each system, were taken with a soil auger from the topsoil layer (0-30 cm) from the booting to the flowering stage of winter wheat. On the same plots, the disturbed soil samples (0.5 kg) were collected, gently manually broken, transferred to carton boxes, and stored as air-dried samples at room temperature prior to analysis of soil structure. Soil texture was determined using the pipette method, with sodium pyrophosphate as a dispersing agent. Aggregate fraction distribution was determined by the standard dry-sieving method (Savinov, 1936). Briefly, 500 g of air-dried, undisturbed sample is sieved through a nest of sieves having 10, 5, 3, 2-, 1-, 0.5-, and 0.25-mm square openings so eight aggregate size classes are obtained (>10, 10-5, 5-3, 3-2, 2-1, 1-0.5, 0.5-0.25 and <0.25 mm).

Aggregate size distribution, expressed as the structure coefficient (Ks), is calculated according to Shein *et al.* (2001) by using the formula:

$$Ks = a / b$$

where a represents the weight percentage of aggregates 0.25-10 mm and b represents the weight percentage of aggregates <0.25 mm and >10 mm (Ćirić *et al*., 2012). Soil structure was also determined by wet sieving method procedure to obtain 4 classes of aggregates >2000 μm, 250–2000 μm, 53–250 μm and <53 μm. The indicator used to determine the stability of soil structural aggregates is the mean weight diameter (MWD), according to (Hillel, 2004):

$$MWD = \sum_{i=1}^{n} \bar{x}iwi$$

Percentage of waterstable aggregates (% WSA) was calculated as follow

$$WSA\ (\%\ soil >250\mu m) = \frac{WSA-S}{(Wa.g\ x\ k)-S}\ X\ 100$$

Where WSA represents the mass of waterproof soil aggregates after drying in the dryer, Wag - total weight of soil sample (100g), S - mass fraction of coarse sand and K – correction factor (total mass of all fractions after drying / mass of air-dry soil). SOC in total soil samples was determined by using the dichromate ($K_2Cr_2O_7$) wet oxidation method with external heating, followed by titration with ferrous ammonium sulfate (Mohr’s salt). Grinding the samples in a mill and sieving through a sieve with 2 mm diameter preceded the analysis. Labile carbon, considered the portion of SOC, was extracted with hot water (HWOC) using the Ghani *et al.* (2003) procedure. 10 g of the soil of each 4 classes of aggregates were put in a 50 ml cuvette (< 2 mm) and 40 ml of distilled water was added to the air-dried soil. The cuvettes were put into a horizontal shaker on 30 rpm for a period of 30 min. After that, the samples in the cuvettes were transferred into a steam hot-water bath at 80 °C temperature, for a period of 16h. The next phase involved centrifugation on an MSEc centrifuge (Measuring & Scientific Equipment LTD., London) with 3000 rpm for 20 minutes. After centrifugation, the substrate was filtered through a 0.45 μm ME 25/21 CT filter. Determination of labile carbon content, in each soil class of aggregates, was done by the Tyrin’s titrimetric method using dichromate ($K_2Cr_2O_7$) with external heating, followed by titration with ferrous ammonium sulfate (Mohr’`s salt). To calculate the potential of C saturation soil particles <20 μm was done with equation of Hassink (1997) $C_{satpot}$ =4.09 x 0.37 x ≤μm particles (%), where $C_{satpot}$ is potential of C saturation (mg $g^{-1}$) of fine soil particles. The difference between the protection capacity of the fine fraction and current C content correspond to saturation deficit $C_{satdef}$=$C_{satpot}$-$C_{cur}$; where $C_{cur}$ represent the current mean of C in fine fractions. $C_{cur}$ in fine fraction was calculated with the formula C (g kg-1) = (HWOC (μg g-1)) -134,3/21,54 (r=0,87**) (Šeremešić *et al.*, 2013). The total amount of the C sequestration potential was calculated using the Wiesmeier *et al.* (2014) equation $C_{seq}$=$C_{satdef}$ x bulk density x depth x $10^{-2}$. The obtained data were analyzed statistically by analysis of variance (ANOVA) using the software system STATISTICA 12.6, StatSoft, Inc.

## RESULTS AND DISCUSSION

Comparison of different land-use systems reveals similar chemical properties between organic and conventional land use systems (Table 1). Based on the results of agrochemical analyzes of soil samples taken from a depth of 0-30 cm, all sites were neutral in pH reaction. SOM content in the bulk soil samples largely varies from 1.79 to 3.94%, but the average content of SOM is similar in organic and conventional plots 3.09% and 3.08%, respectively. Given that the soils in Vojvodina province are under pressure of SOM loss (Šeremešić *et al*., 2020), the obtained results reveals that the selected locations are representing majority of arable soils. In addition to that, based on SOM values, selected locations for organic agriculture are partially suitable for this particular system of agriculture. The most fertile soil is located at the Nadalj and the lowest sampling location was Šuljam at Fruška Gora Mountain. Comparative analyses of Harchegani-Kiani *et al*. (2019) also indicated that the different land use type has not display significant effects on SOC in calcareous soils of semi-arid climate.

Table 1. Chemical properties of soil samples of different land-use systems

| Location | System | pH | | $CaCO_3$ % | SOM % | Total N % | AL-$P_2O_5$ mg/100g | AL-$K_2O$ mg/100g |
|---|---|---|---|---|---|---|---|---|
| | | KCl | $H_2O$ | | | | | |
| Pančevo | org | 7.10 | 7.86 | 8.70 | 3.94 | 0.20 | 25.78 | 19.73 |
| | con | 7.26 | 8.04 | 10.77 | 3.53 | 0.18 | 16.68 | 18.97 |
| Šuljam | org | 6.89 | 7.97 | 3.31 | 1.93 | 0.10 | 5.30 | 17.99 |
| | con | 7.06 | 8.02 | 3.73 | 1.79 | 0.09 | 8.71 | 18.36 |
| Nadalj | org | 7.11 | 7.86 | 4.14 | 3.79 | 0.19 | 21.38 | 20.54 |
| | con | 7.10 | 7.97 | 4.14 | 3.84 | 0.19 | 9.59 | 19.21 |
| Temerin | org | 6.94 | 7.96 | 2.07 | 2.87 | 0.14 | 4.95 | 24.26 |
| | con | 6.42 | 7.31 | 2.49 | 3.29 | 0.16 | 5.67 | 31.34 |
| Zemun Polje | org | 7.18 | 8.03 | 5.80 | 2.46 | 0.12 | 26.34 | 29.68 |
| | con | 7.01 | 7.76 | 3.31 | 2.68 | 0.13 | 23.96 | 23.74 |
| Pivnice | org | 7.27 | 8.11 | 8.70 | 3.57 | 0.18 | 13.36 | 16.30 |
| | con | 7.21 | 8.00 | 6.22 | 3.37 | 0.22 | 11.74 | 24.99 |
| Average | Org | 7.08±0.14 | 7.96±0.10 | 5.45±2.7 | 3.09±0.8 | 0.16±0.04 | 16.19±9.7 | 21.42±4.8 |
| | Con | 7.00±0.30 | 7.85±0.12 | 5.11±3.4 | 3.08±0.7 | 0.16±0.05 | 12.73±6.61 | 22.78±5.2 |

The mechanical composition reveals that soils belongs to loamy clay with favorable ratio of clay and loamy fractions. Based on the analysis of the mechanical composition, soil samples are significantly uniform by localities, but also by individual comparisons (Table 2). In this way, preconditions are created for comparison of soil structural and analyses of soil organic matter in order to interpret the impact of the production system on other physical and chemical properties of the soil. Greater variation was found in the content of clay and fine sand compared to silt fraction. Vojvodinian Chernozem is considered to be a well-structured soil. Our study confirmed this hypothesis. This can be explained with the facts that at the time of sampling winter wheat crop stand protected soil from disintegration processes and dispersion.

Table 2. Soil texture of soil samples from a different location and land-use systems

| Location | Parcel | Coarse sand | Fine sand | Silt | Clay | Total sand | Silt + Clay | Texture class (Tommerup) |
|---|---|---|---|---|---|---|---|---|
| Pančevo | org | 0.70 | 46.66 | 26.56 | 26.08 | 47.36 | 52.64 | loamy clay |
| | con | 0.90 | 46.26 | 29.28 | 23.56 | 47.16 | 52.84 | clay loam |
| Šuljam | org | 0.20 | 36.84 | 32.24 | 30.72 | 37.04 | 62.96 | loamy clay |
| | con | 0.30 | 39.46 | 30.64 | 29.60 | 39.76 | 60.24 | loamy clay |
| Nadalj | org | 0.10 | 43.22 | 30.08 | 26.60 | 43.32 | 56.68 | loamy clay |
| | con | 0.90 | 45.02 | 27.84 | 26.24 | 45.92 | 54.08 | loamy clay |
| Temerin | org | 1.10 | 39.42 | 24.08 | 35.40 | 40.52 | 59.48 | loamy clay |
| | con | 0.60 | 37.52 | 26.08 | 37.80 | 34.12 | 63.88 | loamy clay |
| Zemun | org | 0.30 | 44.10 | 28.12 | 27.48 | 44.40 | 55.60 | loamy clay |
| Polje | con | 0.60 | 40.96 | 30.28 | 28.16 | 41.56 | 58.44 | loamy clay |
| Pivnice | org | 1.00 | 42.00 | 30.64 | 26.36 | 43.00 | 57.00 | loamy clay |
| | con | 1.00 | 45.72 | 28.96 | 24.32 | 46.72 | 53.28 | clay loam |
| | Org | 0.57 | 42.04 | 28.62 | 28.77 | 42.61 | 57.39 | loamy clay |
| | Con | 0.72 | 41.82 | 29.18 | 28.28 | 42.54 | 57.46 | loamy clay |

The results of dry sieving show that soils from organic plots have the largest representation of the aggregates in size of 10-5 mm, whereas the lowest representation of the aggregate of <0.25 mm. Samples from the conventional plots have the largest representation of the aggregate size 2-1 mm and were lowest in <0.25 mm and 0.5-0.25 mm aggregate size (Table 3). However, comparing organic and conventional land-use systems after dry sieving showed a differences in the fractions of 0.5 - <0.25 mm in favor of conventional agriculture indicating less dispersed soil that can better resist the occurrence of the water and eolian erosion. Consequently, this could be attributed to the favorable crop density and root traits that can contribute to the erosion control and maintenance of soil physical properties (Le Bissonnais *et al.*, 2018). On the other hand, a higher proportion of the 10-5 mm aggregates under organic systems indicated poor soil preparation and potential compaction. In average, in this study we determined 82.4% agronomically valuable aggregates (10-0.25 mm size). Our results are comparable with findings of Ćirić *et al.* (2012) on Chernozem in which 84.09% of aggregates after dry sieving was classified as agronomically valuable. Commonly, organic farmers are less equipped with the efficient machinery compared to conventional farmers. Based on the obtained results of soil structural properties, we speculate that plots in organic production rely on shallow, or conservation tillage which is not sufficient for crop requirement that aggravates weed control (Nikolić *et al*., 2018; Rajković *et al*., 2021). It can be noticed that the production system does not affect much the structure coefficient (K), with the exception of the Nadalj location, where the structure coefficient is significantly higher in the soil samples from the organic plot. This can be explained by the fact that soil in Nadalj has the highest content of organic matter and has been regularly receiving the animal manure. For both land-use systems, wet sieving showed the least distribution of higher aggregate fraction >2000 μm in the 0-30 cm layer, which is in line with previous research (Šeremešić *et al*., 2020). The highest representation of aggregates was in the fractions 250-53 μm and <53 μm (Table 3). It should be emphasized that the distribution of large fractions is conditioned by the soil tillage, while for the smaller fractions the effect of the quality and quantity of organic cementations substances is more important and independent of tillage (Zhang *et al*., 2017). Jugović et al. (2020) showed that selection of an optimal system of soil tillage can decrease the soil degradation for the purpose of the environment protection. Soil samples after wet sieving procedure showed that there are more aggregates of 250-53 μm and <53 μm size on organic plots compared to conventional plots. Conversely, on conventional plots, the aggregates >2000 μm and 2000-250 μm size were highest (Table 3). It follows that the soil from plots in organic production can be less resistant to rainfall dispersion. Our findings are contrary to those reported in Nešić *et al*. (2014) study in which the stability of soil aggregates was higher in the soils at the organic farms across different soil types. Based on the average MWD and WSA, we can assume that the individual methods used for tillage had a significant impact on these indicators to a greater extent compared to the land-use systems. Stabilization of the physical properties of soil in organic production requires a longer period of time and adaptation of the different tillage methods. Given that the average structural properties of two land use systems are similar at each location individual approach must be chosen to improve cropping management toward SOC and structure preservation.

Soil chemical properties of investigated sites reveals that the average total SOM content of different land use system (Table 1.) were similar and belongs to the soil class well provided with humus, such as more than 50% of arable land in AP Vojvodina (Sekulić *et al.*, 2010). Average values from conventional and organic plots indicate that the content of labile organic matter is lower on organic plots (Table 5). High WEOC extractability indicates the presence of potentially readily degradable SOC, whereas low extractability indicates the presence of SOC with low degradability (Breulmann, 2011).

Table 3. Soil dry aggregate size distribution and size classes of stable aggregates after wet sieving procedure

| Location | System | Soil dry aggregate size distribution: Aggregate class % >10 | 10-5 | 5-3 | 3-2 | 2-1 | 1-0.5 | 0.5-0.25 | <0.25 | Ks | Wet sieving: Size classes of stable aggregates (μm) 8000-2000 | 2000-250 | 250-53 | <53 | MWD (mm) | WSA (%) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Pančevo | org | 5.29 | 12.70 | 11.12 | 8.18 | 14.26 | 16.78 | 15.80 | 15.84 | 3.73 | 4.83 | 20.30 | 40.04 | 35.35 | 0.53 | 25.00 |
| | con | 5.56 | 16.03 | 14.02 | 8.53 | 14.31 | 15.35 | 12.33 | 13.87 | 4.15 | 2.30 | 27.96 | 43.80 | 25.94 | 0.50 | 30.26 |
| Šuljam | org | 22.45 | 31.16 | 14.17 | 8.46 | 12.01 | 7.19 | 2.92 | 1.63 | 3.15 | 7.32 | 20.09 | 28.07 | 44.51 | 0.53 | 27.00 |
| | con | 19.92 | 26.07 | 13.31 | 9.49 | 15.64 | 9.98 | 3.72 | 1.86 | 3.59 | 6.30 | 24.00 | 27.70 | 44.04 | 0.63 | 30.00 |
| Nadalj | org | 4.06 | 15.45 | 15.06 | 10.18 | 20.72 | 20.04 | 10.34 | 4.54 | 10.67 | 2.26 | 17.22 | 38.80 | 41.71 | 0.37 | 19.00 |
| | con | 5.64 | 9.98 | 14.40 | 12.83 | 25.74 | 18.16 | 7.96 | 5.28 | 8.17 | 11.53 | 26.85 | 26.40 | 35.21 | 0.91 | 38.38 |
| Temerin | org | 15.51 | 32.08 | 17.00 | 10.49 | 13.56 | 6.87 | 2.99 | 1.48 | 4.88 | 11.90 | 34.26 | 24.78 | 28.75 | 1.02 | 46.00 |
| | con | 16.98 | 17.84 | 13.36 | 10.30 | 19.69 | 14.20 | 5.77 | 1.85 | 4.31 | 5.72 | 33.93 | 26.31 | 34.05 | 0.71 | 39.65 |
| Zemun Polje | org | 11.50 | 19.70 | 15.03 | 10.04 | 17.99 | 16.09 | 7.23 | 2.42 | 6.18 | 2.02 | 19.68 | 29.19 | 49.09 | 0.38 | 22.00 |
| | con | 12.18 | 16.83 | 15.26 | 10.85 | 20.43 | 16.04 | 6.60 | 1.80 | 6.15 | 3.35 | 25.83 | 36.80 | 34.01 | 0.52 | 29.00 |
| Pivnice | org | 15.47 | 13.49 | 11.06 | 8.37 | 17.45 | 16.96 | 11.40 | 5.79 | 3.70 | 4.55 | 18.42 | 38.01 | 39.01 | 0.61 | 23.00 |
| | con | 16.73 | 16.20 | 13.11 | 10.30 | 17.23 | 14.28 | 8.62 | 3.62 | 3.92 | 4.49 | 24.58 | 32.68 | 38.25 | 0.55 | 29.00 |
| | org | 12.38±6.9 | 20.76±8.7 | 13.91±2.3 | 9.29±1.0 | 16.00±3.2 | 13.99±5.5 | 8.45±5.0 | 5.28±5.4 | **5.39a** | 5.48±3.6 | 21.66±6.8 | 33.15±6.5 | 39.74±7.1 | **0.57a** | **27.00b** |
| | con | 12.84±6.1 | 17.16±5.9 | 13.91±0.8 | 10.38±1.4 | 18.84±4.1 | 14.67±2.7 | 7.50±2.9 | 4.71±4.6 | **5.05a** | 5.62±3.2 | 27.19±3.6 | 32.28±6.9 | 35.25±5.9 | **0.64a** | **32.72a** |

Ks-; MWD; WSA; **Numbers marked with the different color are significant at $p<0.05$ level

The obtained results can be interpreted by the application of mineral fertilizers on conventional plots, i.e., the absence of adequate fertilization in organic production. According to Huang *et al.* (2020) N addition increased soil C stocks and decrease decomposition of old soil C. In organic wheat production, foliar fertilizers are used, which are not sufficient to activate the soil and create satisfactory amounts of assimilates. Generally, > 2000 μm fractions had the highest content of HWOC, while decreasing the size of the fractions reduces its HWOC content, except for fraction <53 μm, in the organic system (Table 4). Comparing the content of labile organic matter by fractions and by type of production shows that fractions >2000 μm, and 250-53 μm from conventional plots contain more labile organic matter compared to the same fractions from organic production, while in fractions 2000-250 μm and <53 μm, higher content of labile organic matter was determined in samples taken from organic plots. Given the carbon content in the different aggregate fractions, obtained data support the aggregate hierarchy model. Soils under organic agricultural system manage to preserve the same amount of the SOC in the condition with organic fertilization and potentially lower input of fresh C from the crop residue and less mineral nitrogen. These results are different from those presented by Marriott and Wander (2006) where organic farming increased the SOC by 14% compared with conventional counterparts probably because of a variety of soil types used in this study. In this sense, preservation derives from the manure application, also elaborated in Spiegel *et al*. (2010). Stabilization of the physical properties of soil in organic production requires a longer period and adaptation of the tillage system.

However, in addition to the carbon content in the soil, the dynamics of carbon is much more important, which indicate the connection between organic matter and soil structure (physical soil). Hassink (1997) found a strong correlation of SOC stored in the fraction containing silt and clay particles in a wide range of topsoils of temperate and tropical regions that can be a basis of assessment for stable SOC saturation. The saturation deficit $C_{satdef}$ in our study point to the amount of carbon that can be stored in soil until the protection capacity is reached (Table 5). $C_{satdef}$ was higher at organic plots compared to conventional one possibly as consequence of reduced mineral nitrogen application that is required for balanced C/N ratio that lead to C sequestration. Conversely, somewhat higher $C_{seq}$ was calculated at organic systems (2.84 kg $m^{-2}$) compared to conventional (2.64 kg $m^{-2}$). In his study Wiesmeier *et al.* (2014) showed higher sequestration potential of cropland (>4 kg $m^{-2}$) that correspond to our findings. Enhancing the SOM pool is a major challenge in both land-use systems, but benefits have long-term effects including improvement in soil structure, retention of water and plant nutrients, increase in soil biodiversity and decrease in risks of soil erosion and the related degradation (Lal, 2009).

$C_{satpot}$ ratio in bulk soil C indicate the overall (historical) loss of soil organic carbon in soil. We found that for Chernozem soil this value is amounted to 71-72% which leads to the conclusion that in long-term soil has lost approximately 30% of initial soil organic carbon in the topsoil. This could be mainly attributed to tillage but also to other unfavorable agronomic practices such as reside burning.

Table 4. HWOC content in water-stable aggregates

| Location | System | HWOC (μg $g^{-1}$) | | | | |
|---|---|---|---|---|---|---|
| | | Size classes of stable aggregates | | | | Average |
| | | 8000-2000 | 2000-250 | 250-53 | <53 | |
| Pančevo | org | 425.3 | 329.8 | 271.4 | 254.3 | 332.7 |
| | con | 451.2 | 386.8 | 298.7 | 255.3 | 335.5 |
| Šuljam | org | 305.1 | 271.7 | 184.4 | 222.2 | 245.8 |
| | con | 369.8 | 213.9 | 235.8 | 170.5 | 247.5 |
| Nadalj | org | 429.2 | 362.9 | 242.1 | 257.7 | 322.9 |
| | con | 332.3 | 328.9 | 353.7 | 235.8 | 312.7 |
| Temerin | org | 365.5 | 241.7 | 246.5 | 253.3 | 289,1 |
| | con | 373.5 | 295.7 | 212.4 | 194.8 | 256.5 |
| Zemun Polje | org | 383.7 | 280.9 | 154.2 | 166.9 | 246,4 |
| | con | 366.5 | 248.5 | 195.3 | 177.1 | 246.8 |
| Pivnice | org | 371.2 | 283.9 | 236.9 | 212.4 | 276.1 |
| | con | 374.9 | 338.7 | 255.0 | 231.9 | 300.1 |
| Average | org | **388. 3±64** | **295.1±48** | **230.8±59** | **227.8±38** | **285.5** |
| | con | **378.1±43** | **285.3±55** | **258.5±65** | **210.8±37** | **383.1** |

Table 5. Carbon sequestration potential of investigated land use systems

| Cropping system | $C_{satpot}$ (g $kg^{-1}$) | $C_{cur}$ (g $kg^{-1}$) (fine fraction) | $C_{satdef}$ (g $kg^{-1}$) | $C_{seq}$ (kg $m^{-2}$) | C bulk soil (g kg-1) | $C_{satpot}$/ C bulk soil |
|---|---|---|---|---|---|---|
| Organic | 25.33 ±1.3 | 15.06±3.9 | 10.27±4.3 | 2.84±1.2 | 17.92±4.6 | 71.5% |
| Conventional | 25.07±1.6 | 15.56±4.1 | 9.51±5.5 | 2.64±1.5 | 17.88±4.2 | 72.2% |

## CONCLUSIONS

Our results showed similar content of SOM on both land-use systems indicating the capability of organic farms to preserve SOM with fewer inputs. We found higher content of soil organic matter stored in the micro aggregate size classes >2000 μm indicating their importance in SOM preservation. Carbon saturation deficit is somewhat higher at organic plots as well as carbon sequestration rate. Accordingly, proper interaction of soil structural properties and soil organic matter fractions could assure sustainable development of organic farms. It follows that the organic producers should pay attention on cultivation methods, timing of tillage operation and fertilization. Additional research is needed to obtain the quantitative basis for evaluating single amendment and practice to increase SOM content and macro aggregation as well as long-term soil fertility.

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