MONITORING OF DIFFERENT CULTIVATED AND NATURAL GRASSLAND SOILS BASED ON SOME MICROBIOLOGICAL CHARACTERISTICS IN EASTERN HUNGARY

Magdolna TÁLLAI[1], Zsolt SÁNDOR [1], Kármen Evelin JUHASZ[1], Andrea Kovács BALLA[1], János KÁTAI[1]

[1] University of Debrecen, Faculty of Agriculture and Food Sciences and Environment Management, Institute of Agricultural Chemistry and Soil Science, Debrecen, HUNGARY

REVIEW

Abstract

The monitoring of intensively farmed areas and soils is a very important task. In our comparative study, we were examined three different soil types with different cultures based on some microbial properties in the Eastern Hungary region (2019-2021). The moisture content of the soil samples was during the three years average 10-19%. We observed that during the three consecutive years the moisture content in soils decreased. The highest activity of saccharase (SA) (7.21 mg glucose 100 g^{-1} $24h^{-1}$), urease (UA) (65.34 NH_4^+ mg^{-1} $100g^{-1}$ 2h), and dehydrogenase activity (DA) (219.55 µg INTF g^{-1} $2h^{-1}$) was in solonetz soil, which natural uncultivated, pasture. The phosphatase activity (PA) (14.84 P_2O_5 mg^{-1} $100g^{-1}$ 2h) was higher in the chernozem soil, it was almost the same for sand (6.47 P_2O_5 mg^{-1} $100g^{-1}$ 2h) and grass (6.69 P_2O_5 mg^{-1} $100g^{-1}$ 2h). The CO_2 production was 18.44 on the chernozem, 15.65 on the humus sand, and 19.11 mg $100g^{-1}$ 7 $days^{-1}$ on the solonetz soil. Grasslands create a specific environment for the organisms that live in them. The large root masses of grass provide an important source of organic matter for micro-organisms. The enzymes activities and the CO_2 production were also more intensive on undisturbed pasture soil utilization natural grassland than in soils under intensive cultivations.

Keywords: *soil enzymes, CO_2 production, chernozem, sandy soil, grassland*
Corresponding author: Magdolna Tállai; e-mail: tallaim@agr.unideb.hu

INTRODUCTION

The quality of the agricultural land has been decreasing due to the intensive farming (Eswaran et. al, 2001; FAO, 2015; Panagos et. al, 2018a).

This is the reason that we choose three different cultivation forms to measure some microbiological parameters of soils of Hajdú-Bihar County. Two of the soils were cultivated – with fruit orchard and wheat – the third one was a natural grassland; they had different soil types. Soils were mainly analysed about soil enzymes activity.

Several studies have shown that soil enzymes are not suitable for total characterising the biological activity of soils (Doran & Zeiss, 2000; Niemeyer et. al. 2012), but soil enzymes are constantly playing vital roles for the maintenance of soil ecology and soil health (Acosta-Martínez & Tabatai, 2000). Enzymes activity is a good indicator of changes of organic matter content, as they provide information about soil microbiological status and physico-chemical conditions (Chu et al, 2020; Jaskulak, & Grobelak, 2020; Fannin et. al, 2022).

These enzymatic activities in the soil are mainly of microbial origin, being derived from intracellular, cell-associated or free enzymes. Therefore, microorganisms are acting as the indicators of soil health, as they have active effects on nutritional cycling, also affecting the physical and chemical properties of soil. The potential enzymes playing major roles in maintaining soil health according to Shonkor Kumar & Ajit Varma, 2010 are the following – amylase, arylsulphatase, β-glucosidase, cellulase, chitinase, dehydrogenase, phosphatase, protease, and urease.

Another, very important microbiological indicator in soil is CO_2 production (Biró et al. 2018). According to Kong et al. (2013a) research, land use has a significant effect on the cumulative CO_2 productions in soil. Larger amount of gases was emitted by horticultural plant – apple, orchard - compared to grassland or forest soils.

MATERIAL AND METHOD

The examined three soil types were about some microbial parameters *(1)*Calcareous Chernozem *(Chernozems)* with corn (*Triticum aestivum L.*) from Debrecen-Látókép - $pH_{(H2O)}$=6.8; *(2)*Humus sandy soil *(Arenosols)* from Debrecen - Pallag - $pH_{(H2O)}$=5.8, with fruit (*Prunus cerasus L.*) – and *(3)S*olonetz soil *(Solonetz)* with grassland Hajdúnánás – Tedej, $pH_{(H2O)}$=6.6.

Soil samples were taken during 3 years (2019-2021), in the spring (in the month of May) and in the autumn (in the month of September), from the top 20 cm – the most active – layer of the soil. The areas have received only natural rainfall.

Moisture content was measured by drying the soil at 105°C for 24h (Buzás, 1988).

The CO_2-production was measured after 7 days' incubation with NaOH-trapping (Öhlinger, 1996). The quantitative determination of monosaccharides originated from the breakdown of saccharase (SA) according to Frankenberger és Johanson (1983) was measured. Measurement of urease activity (UA) (Kempers cit. Filep, 1995) was done based on the quantitative determination of ammonia; the phosphatase activity (PA) (Öhlinger, 1996) was measured about the quantity of hydrolyzed phosphorus acid, and the dehydrogenase activity (DHA) was determined, where the soil samples were mixed with INT-solution, incubated 2h at 40 °C (Mersi, 1996).

The results of the examination were subjected to one-way ANOVA by using Eisenhauer et al. (2012) and IBM SPSS Version 28.0. Means were compared by Duncan's Multiple Range Test (Duncan, 1955) at $p < 0.05$.

RESULTS AND DISCUSSIONS

The moisture content of the soil samples was average in the soils during the three years 11-19%. (Figure 1). The lowest value was found in Pallag sand (10.47%), while the highest value was measured in the chernozem soil (18.78%). We also observed that during the three consecutive years the moisture content in the soil decreased in all three areas, to a lesser extent in the chernozem (19.28-17.80%) and the solonetz soil (12.64-11.21%), at the same time, in the area of sand to a larger extent (12.61-9.22%) in the orchard. This is probably related to the fact that sandy soils are poor in colloids and have a low water holding capacity.

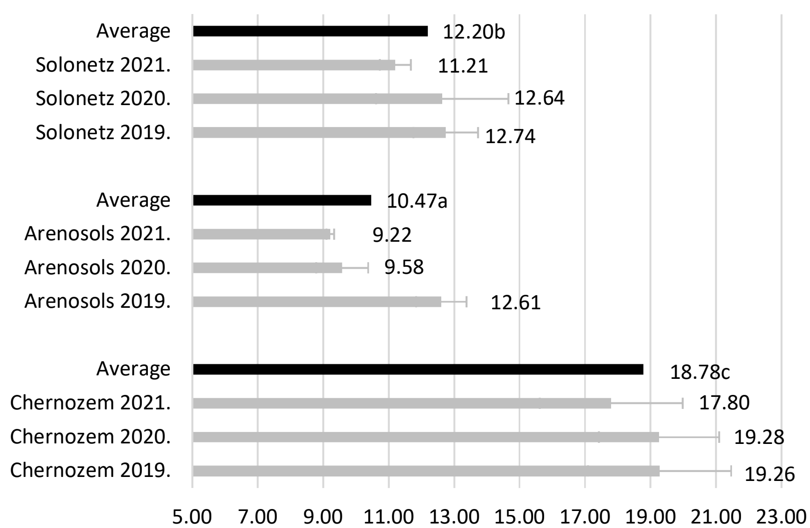

Figure 1 Moisture contents of examined soils in Eastern Hungary region (2019-2021)

The highest SA (7.21 mg glucose 100 g^{-1} $24h^{-1}$), UA (65.34 NH^{4+} mg^{-1} $100g^{-1}$ 2h), and DHA (219.55 µg INTF g^{-1} $2h^{-1}$) was in Solonetz soil, which is a natural uncultivated, pasture. The PA (14.84 P_2O_5 mg^{-1} $100g^{-1}$ 2h) was higher in the chernozem soil, it was almost the same for sand (6.47 P_2O_5 mg^{-1} $100g^{-1}$ 2h) and grass (6.69 P_2O_5 mg^{-1} $100g^{-1}$ 2h) (Table 1).

Table 1 Enzyme activities and CO_2 production of examined soils in Eastern Hungary region (2019-2021)

Date of soil sampling	Soil type and seasonality	SA (glucose mg·100g^{-1} ·24h^{-1})	PA (P_2O_5 mg· 100g^{-1}·2h^{-1})	UA (NH_4-N mg·100g^{-1} ·2h^{-1})	DHA activity (INTF µg ·g^{-1}·2h^{-1})	CO_2 emission (mg· 100g^{-1}· 10 days^{-1})
Chernozem with wheat						
2019.	spring	5.12ef$^{\pm0.75}$	14.29de$^{\pm1.69}$	42.12e$^{\pm4.05}$	129.93d$^{\pm11.54}$	16.94cdefg$^{\pm2.04}$
	autumn	5.17ef$^{\pm0.68}$	14.27de$^{\pm0.63}$	33.99cd$^{\pm2.92}$	134.64d$^{\pm12.62}$	22.03ij$^{\pm2.49}$
2020.	spring	6.38gh$^{\pm0.63}$	16.85f$^{\pm1.80}$	39.95de$^{\pm4.73}$	129.88d$^{\pm13.00}$	24.42j$^{\pm3.60}$
	autumn	4.70de$^{\pm1.13}$	15.63ef$^{\pm0.25}$	31.38c$^{\pm3.49}$	137.72d$^{\pm10.25}$	22.96ij$^{\pm2.44}$
2021.	spring	6.87ghi$^{\pm0.41}$	14.55de$^{\pm0.58}$	37.27d$^{\pm0.57}$	109.49c$^{\pm0.72}$	12.55ab$^{\pm0.33}$
	autumn	3.87cd$^{\pm0.11}$	13.47d$^{\pm0.87}$	39.55de$^{\pm2.13}$	119.45cd$^{\pm1.91}$	11.72a$^{\pm0.22}$
	Average	5.35	14.84	37.38	126.85	18.44
Arenosols with cherry						
2019.	spring	3.61bcd$^{\pm0.59}$	7.87bc$^{\pm3.19}$	21.02ab$^{\pm3.42}$	66.71ab$^{\pm9.33}$	13.72abc$^{\pm2.62}$
	autumn	2.90abc$^{\pm0.69}$	5.96ab$^{\pm0.24}$	18.06ab$^{\pm1.99}$	77.58ab$^{\pm18.59}$	15.03bcd$^{\pm3.16}$
2020.	spring	4.34de$^{\pm0.89}$	6.23ab$^{\pm0.37}$	21.78ab$^{\pm2.45}$	57.90a$^{\pm10.38}$	17.08defg$^{\pm1.20}$
	autumn	2.56ab$^{\pm0.49}$	6.06ab$^{\pm0.20}$	14.66a$^{\pm1.93}$	85.53b$^{\pm18.18}$	17.68defg$^{\pm1.91}$
2021.	spring	2.34a$^{\pm0.45}$	6.38abc$^{\pm0.22}$	22.76b$^{\pm3.45}$	69.53ab$^{\pm1.66}$	15.82cde$^{\pm0.43}$
	autumn	2.42a$^{\pm1.03}$	6.35abc$^{\pm0.40}$	14.87a$^{\pm2.86}$	77.35ab$^{\pm5.85}$	14.54abcd$^{\pm0.74}$
	Average	3.03	6.47	18.86	72.43	15.65
Solonetz with grassland						
2019.	spring	7.59i$^{\pm0.96}$	8.22c$^{\pm0.89}$	72.22h$^{\pm4.78}$	161.50e$^{\pm17.26}$	16.38cdef$^{\pm2.14}$
	autumn	6.49gh$^{\pm0.67}$	5.72a$^{\pm1.19}$	56.37fg$^{\pm5.13}$	274.08g$^{\pm21.01}$	21.02hij$^{\pm1.07}$
2020.	spring	9.46j$^{\pm1.40}$	7.18abc$^{\pm0.92}$	73.29h$^{\pm14.20}$	183.55f$^{\pm19.36}$	20.16ghij$^{\pm3.79}$
	autumn	7.17hi$^{\pm0.57}$	5.92ab$^{\pm0.16}$	53.05f$^{\pm6.97}$	342.18h$^{\pm20.04}$	18.86efgh$^{\pm2.00}$
2021.	spring	6.73ghi$^{\pm0.50}$	6.86abc$^{\pm1.92}$	76.74h$^{\pm0.05}$	169.41ef$^{\pm4.43}$	19.55fghi$^{\pm0.33}$
	autumn	5.86fg$^{\pm0.11}$	6.26ab$^{\pm0.10}$	60.35g$^{\pm3.04}$	186.58f$^{\pm5.84}$	18.72efgh$^{\pm0.22}$
	Average	7.21	6.69	65.34	219.55	19.11

The CO_2 production of the soils was 18.44 on the chernozem soil, 15.65 on the humus sand soil, and 19.11 mg 100g^{-1} 7 days^{-1} on the solonetz soil (Figure 2).

Regarding the seasonality, the SA and PA was not significantly higher, while the activity of UA was significantly higher in spring. DHA showed higher activity in autumn, while soil CO_2 production was also in an unprovable way higher in autumn than in spring (Table 1; Figure 2).

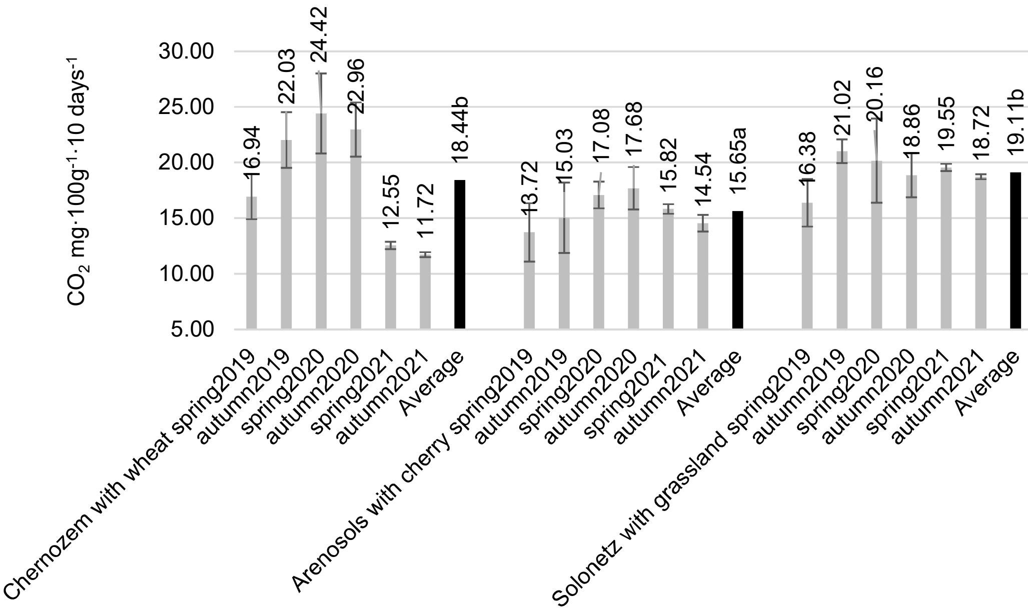

Figure 2 CO_2 emission of examined soils in Eastern Hungary region (2019-2021)

CONCLUSIONS

The long-term monitoring of our soils is a very important task in order to be informed about the condition of our soils. Protecting our soils and studying the impact of human activity on soils is also very important.

Grasslands create a specific environment for the organisms that live in them. The large root masses of grass provide an important source of organic matter for micro-organisms.

According this study, the measured enzyme activities ((saccharase (SA); urease (UA); dehydrogenase (DHA)) and the CO_2 production were also more intensive on undisturbed pasture soil utilization natural grassland than in soils under intensive cultivations.

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