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VPLYV ZRNITOSTNÉHO ZLOŽENIA PÔDY NA KVANTITU A KVALITU PÔDNEJ ORGANICKEJ HMOTY

INFLUENCE OF PARTICLE SIZE DISTRIBUTION OF SOIL ON QUANTITY AND QUALITY OF SOIL ORGANIC MATTER

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Influence of particle size distribution of soil on the carbon and nitrogen contents and fractional composition of humus substances was studied in different soil types (Eutric Fluvisol, Haplic Chernozem, Haplic Luvisol, Eutric Regosol). The variants include soils of forest ecosystem (control) and agro-ecosystem with 4 crop rotations. The particle size distribution of soil influenced the content and quality of soil organic matter. It was noted that, the higher proportion of smaller fraction (<0.001 mm) supported, the higher content of soil organic matter ($r = 0.794$; $P < 0.01$) subjected to smaller changes ($r = 0.551$; $P < 0.05$). Higher content of size fraction <0.001 mm supported higher stability of humus substances ($r = -0.755$; $P < 0.01$) and humic acids ($r = -0.533$; $P < 0.05$). The humic acids bound with mineral components and stabile R_2O_3 were dominated. In contrary, higher content of size fraction (0.05 – 0.25 mm) contributed higher content of fulvic acid bound with mobile R_2O_3 and higher content of free fulvic acids. Higher content of organic matter was in forest ecosystem, but its quality was better in arable land.

Key words: particle size distribution, soil organic matter, agro-ecosystem, forest ecosystem

Soil organic matter (SOM) is a key element of soil, which determines its production capacity (Robinson et al., 1994), and the quality of soil (Doran and Parkin, 1994). The SOM content depends on the balance between the carbon inputs and the rate of their decomposition (Saggar et al., 2001; Huang et al., 2002). The carbon content influences the number of factors, including soil types, natural content of organic matter in soil (MacRae and Mehuys, 1985), the annual input of root residues and root exudates (Ushakov et al., 1985) or particle size distribution (Amelung et al., 1998; Šimanský and Horvátová, 2010; Šimanský et al., 2009). The content of the SOM is in positive correlation with clay fraction (Bosatta and Ågren, 1997; Jurčová and Tobiašová, 2002). Jastrow (1996) observed that just clay minerals are in conjunction with a large proportion of organic substances; thereby they contribute to its stabilisation.

Carbon stocks in many agricultural soils in recent decades decreased due to agricultural intensification and inappropriate land use (Hermle et al., 2008). Conversion of natural ecosystems to cropland increases carbon losses due to increased intensity of mineralization and reduced carbon inputs (Gregorich et al., 2005). Conversion of forest to arable land leads primarily to a reduction of carbon content and changes in its distribution (Ross, 1993; Singh and Singh, 1996). In agro-ecosystem, maintenance of organic carbon content is the main role in reducing of soil degradation (Bhattacharyya et al., 2009). In agro-ecosystem, the amount of carbon is also influenced through the management system, including the selection of crops, use of crop residues and tillage intensity (Voroney and Angers, 1995). The carbon content in forest soil is the result of the balance between the organic inputs (plant residues) and losses (microbial degradation, forest fires, erosion and leaching), which vary according to climate, parent rock and time (Jenny, 1994).

The quantity of SOM is given by the contents of total organic carbon and nitrogen (Kubát et al., 2006). The quality of SOM depends on its distribution between labile and stabile components. The stabile organic compounds in soil include humus substances and other macromolecules, which are naturally resistant to the action of microorganisms, or they are physically protected by their adsorption on mineral surfaces or bound within aggregates (Theng et al., 1989). The labile fractions are represented by carbohydrates, amino acids, amino saccharides, or lipids (Woomer et al., 1994). It is assumed that the quality of SOM is reduced by the process of decomposition (Rovira and Vallejo, 2002).

The objectives of this study were as follows: (i) to determine the influence of the particle size distribution on quantity and quality of soil organic matter, (ii) to compare the quantity of soil organic matter in soils under different land use, and (iii) to assess the quality of the organic matter through the parameters of fraction composition of humus, optical parameters of humus substances and carbon and nitrogen parameters.

Material and methods

The studied areas are located in the Danubian lowland. Localities of Eutric Fluvisol (EF) are present on the Danubian flat, and localities of Haplic Chernozem (HC), Haplic Luvisol (HL) and Eutric Regosol (ER) are on the Danubian hill. Geological substrates of the Danubian lowland are neogene clays, sands and gravels, which are covered with loess and loess loam in most such areas. Fluvial sediments are found along the rivers Váh and Nitra. The relief of the Danubian plain is monotonous. The sampling places on the EF are situated near the flat areas on the Váh river. Localities of HC, HL and ER are situated on slight slopes. The average annual temperatures of the studied areas are 9.7 °C (Nitra), 9.8 °C (Šaľa), and 9.3 °C (Topoľčany), and the average rainfall per year is 580 mm

Table 1 Percentages proportions of crops in fields of different soil types

Locality (1)	Variant	Cereals (2)	Oil crops (3)	Legumes (4)	Forage (5)	Annual forage (6)	Root crops (7)
Nitra	HC-01 (a)	66.7	0	0	0	0	33.3
	HC-02	66.7	0	0	0	0	33.3
	HC-03	86.3	0	0	0	0	16.7
	HC-04	66.7	16.6	0	0	0	16.7
Šaľa	EF-01 (b)	42.8	0	0	0	28.6	28.6
	EF-02	42.8	0	0	0	28.6	28.6
	EF-03	57.1	0	0	0	14.3	28.6
	EF-04	71.4	14.3	0	0	0	14.3
Topoľčany	HL-01 (c)	71.4	28.6	0	0	0	0
	HL-02	71.4	28.6	0	0	0	0
	HL-03	71.4	28.6	0	0	0	0
	HL-04	71.4	28.6	0	0	0	0
Topoľčany	ER-01 (d)	57.1	42.9	0	0	0	0
	ER-02	57.1	14.3	0	0	28.6	0
	ER-03	57.1	0	0	42.9	0	0
	ER-04	28.6	28.6	14.2	28.6	0	0

(a) HC-01 – HC-04 – crop rotations on Haplic Chernozem, (b) EF-01 – EF-04 – crop rotations on Eutric Fluvisol, (c) HL-01 – HL-04 - fields on Haplic Luvisol, (d) ER-01 - ER-04 – fields on Eutric Regosol

(a) HC-01 – HC-04 – pozemky na černozemi, (b) EF-01 – EF-04 – pozemky na fluvizemi, (c) HL-01 – HL-04 – pozemky na hnedozemi, (d) ER-01 – ER-04 – pozemky na regozemi

Tabuľka 1 Percentuálne zastúpenie plodín v osevných postupoch na rôznych pôdnych typoch
(1) lokalita, (2) obilniny, (3) olejniny, (4) strukoviny, (5) krmoviny, (6) jednoročné krmoviny, (7) okopaniny

(Nitra), 568 mm (Šaľa), and 607 mm (Topoľčany) (Korec et al., 1997).

The variants included two types of agro-ecosystem (arable land) and forest ecosystem (control) of four soil types (EF, HC, HL, ER). The agro-ecosystem included four crop rotations (Table 1). The forest ecosystems were natural forests with human control. The fields in agro-ecosystems were located in different farms under real production conditions.

The soil samples for particle size distribution determination were collected in three replicates to a depth of 0.30 m in forest ecosystems and agro-ecosystems. All of the samples were dried in a constant-temperature room of 25 – 28 °C, and grinded. The total organic carbon (TOC) was determined by wet combustion (Orlov and Grišina, 1981), the labile carbon (C_L) was determined by $KMnO_4$ oxidation (Loginov et al., 1987), the total nitrogen (NT) was determined by the Kjeldahl method (Bremner, 1960), and the potentially mineralisable nitrogen (N_L) was determined by the Standford and Smith (1978) method. The non-labile carbon (C_{NL}), lability of carbon (L_C), index of carbon lability (L_{IC}), carbon pool index (C_{PI}), carbon management index (C_{MI}), non-labile nitrogen (N_{NL}), lability of nitrogen (L_N), index of nitrogen lability (L_{IN}), nitrogen pool index (NPI), and nitrogen management index (N_{MI}) were also calculated (Blair et al., 1995). The fractional composition of humus substances were determined by Ponomarevova and Plotnikova (1975) method. The particle size distribution was determined after dissolution of $CaCO_3$ with 2 mol.dm^{-3} HCl and decomposition of the organic matter with 30% H_2O_2. After repeated washing, samples were dispersed using $Na(PO_3)_6$. Silt, sand and clay fractions were determined according to the pipette method (Fiala et al., 1999). The obtained data were analysed using Statgraphic Plus statistical software. Correlation analysis was used to determine the relationships between the parameters of soil organic matter and the particle size distribution. Significant correlation coefficients were tested at $P < 0.05$ and $P < 0.01$.

Results and discussion

Higher quantity of total organic carbon (TOC) as well as total nitrogen (NT) was recorded in forest ecosystem than in arable land (Table 2). The soil of forest ecosystem was taken as a control. On the Eutric Regosol, most varied crop rotations were and there were also forage crops, which on the other soil types were not included into the crop rotation. Even organic fertilizers were added, but their doses were minimal in comparison with fields on Haplic Chernozem and Eutric Fluvisol. In case of fields on Haplic Luvisol, organic fertilizers were added, but carbon balance was just below zero. In spite of this, the highest difference of the organic carbon content between plots and control was noted on Eutric Regosol. This soil is characterized by extreme particle size distribution (Table 3).

In natural ecosystem, the total organic carbon content is higher than in arable land, but in this case, soil moisture played also an important role. In forest ecosystem – denser vegetation and suction force of tree roots is higher, which influenced higher soil moisture under forest compared to arable land. Several authors (Meermans et al., 2008; Tan et al., 2004; Ungaro et al., 2005) also found out positive correlation between the soil moisture and content of soil organic carbon, which in this case also contributed to the reducing of differences between the carbon contents of arable land and the forest.

At higher SOM proportion, contents of carbon and nitrogen labile fractions were also higher (Table 3). The contents of these labile fractions, however, were in negative correlation with the fraction of sand, which shows the importance

Table 2 Total organic carbon and total nitrogen in soils of different ecosystems

Locality (1)	Variant	TOC (g) v mg.kg^{-1}	NT (h) v mg.kg^{-1}
Nitra	HC (a)-AL (e)	20 701	1 932
	HC-FO (f)	22 317	1 955
Šaľa	EF (b)-AL	15 460	1 877
	EF-FO	29 547	3 142
Topoľčany	HL (c)-AL	8 893	1 125
	HL-FO	13 950	1 735
Topoľčany	ER (d)-AL	12 443	1 890
	ER-FO	29 670	3 839

(a) HC – Haplic Chernozem, (b) EF – Eutric Fluvisol, (c) HL – Haplic Luvisol, (d) ER – Eutric Regosol, (e) AL – arable land, (f) FO – forest, (g) TOC – total organic carbon, (h) NT – total nitrogen
(a) HC – černozem, (b) EF – fluvizem, (c) HL – hnedozem, (d) ER – regozem, (e) AL – orná pôda, (f) FO – les, (g) TOC – celkový organický uhlík, (h) NT – celkový dusík

Tabuľka 2 Celkový organický uhlík a celkový dusík v pôdach rôznych ekosystémov
(1) lokalita

Table 3 Particle size distribution in soils of different ecosystems

Locality (1)	Variant	Sand in % (2)	Silt in % (3)	Clay in % (4)
Nitra	HC (a)-AL (e)	23.66	56.15	20.20
	HC-FO (f)	28.80	53.76	17.43
Šaľa	EF (b)-AL	29.67	51.59	18.75
	EF-FO	46.25	42.46	11.29
Topoľčany	H (c)-AL	59.60	27.11	13.05
	HL-FO	66.23	23.00	10.77
Topoľčany	ER (d)-AL	40.72	48.23	10.05
	ER-FO	13.07	45.19	28.67

(a) HC – Haplic Chernozem, (b) EF – Eutric Fluvisol, (c) HL – Haplic Luvisol, (d) ER – Eutric Regosol, (e) AL – arable land, (f) FO – forest
(a) HC – černozem, (b) EF – fluvizem, (c) HL – hnedozem, (d) ER – regozem, (e) AL – orná pôda, (f) FO – les

Tabuľka 3 Zrnitostné zloženie pôd rôznych ekosystémov
(1) lokalita, (2) piesok, (3) prach, (4) hlinitá

of smaller size particles in stabilization of organic substances in soil (Tobiašová, 2010).The contents of labile carbon and nitrogen (except of Haplic Chernozem) were higher in forest ecosystem. The stabilization of organic matter in arable land is not only supported by mixing of organic portion with mineral, but also by application of inorganic fertilizers, especially calcium fertilizers. The highest proportion of labile carbon was in Haplic Chernozem, and the difference between arable land and control was the smallest. In case of fields on Haplic Chernozem and Eutric Fluvisol, higher doses of farmyard manure were applied, which is not only an important source of stabile organic compounds (Nannipieri, 1993), but also their labile forms (Kalbitz et al., 2003; Riffaldi et al., 1998). But in case of Eutric Fluvisol, the differences in contents of carbon and nitrogen labile fractions between arable land and control are one of the largest. This is the result of different particle size distribution. In case of Haplic Chernozem, the proportion of size fractions on arable land and in forest was nearly the same, but in case of Eutric Fluvisol, proportion of smaller size fractions was markedly higher on arable land and conversely larger size fractions were recorded in forest. The big difference was also recorded in contents of stabile carbon and nitrogen fractions. This means that inputs of organic matter are high, but the stocks of organic matter in arable land of Eutric Fluvisol are subjected to the larger changes. This is also confirmed by lower values of CMI and NMI in Eutric Fluvisol than in Haplic Chernozem. One of the possibilities is their stabilization by binding to the mineral components of soil. According to Basile-Doelsch et al. (2005), the proportion of organic matter bound to surfaces of clay minerals is 25 – 98 % of total organic matter in soil. According to Tobiašová (2010), the CPI values show higher reduction of soil organic matter in case of arable land on the Haplic Luvisol, medium reduction on the Eutric Regosol and Eutric Fluvisol and low reduction on the Haplic Chernozem.

The carbon and nitrogen contents were in negative correlation with larger size fraction (0.05 – 2 mm), and in positive correlation with smaller size fractions (0.01 – 0.05 and <0.001 mm) (Table 4), which is consistent with the results of Bronson et al. (2004) and Tobiašová (2010). It follows that particle size distribution clearly belongs among the factors which significantly influence the content of soil organic matter. On arable land, another very important factor is the application of organic fertilizers, which can partially eliminate carbon losses caused by the particle size distribution (lighter soils). In case of crop influence, not only the type of crop was very important, but also its cropping system. It makes difference, whether corn is grown for grain or silage, or whether cereal straw remains on the field, or how many years forage is grown (Jurčová, 1998).

Carbon pool index (CPI) and carbon management index (CMI) allow determining the level and following changes in soil organic carbon in agro-ecosystems and natural ecosystems (Blair et al., 1995; Conteh et al., 1998; Šimanský and Zaujec, 2009). Changes can be thus monitored in a shorter time period. The quantity of soil organic matter evaluated by the CPI index,

Table 4 Correlations between the carbon and nitrogen parameters and particle size distribution of soil

	2.00 – 0.25 mm	0.25 – 0.05 mm	0.05 – 0.01 mm	0.01 – 0.001 mm	<0.001 mm
TOC (a)	-0.632^{+}	-0.757^{++}	0.709^{+}	0.473	0.794^{++}
C_L (b)	-0.521^{+}	-0.646^{+}	0.672^{+}	0.268	0.620^{+}
C_{NL} (c)	-0.644	-0.766^{++}	0.697^{+}	0.518	0.763^{++}
L_C (d)	-0.123	-0.275	0.366	-0.078	0.150
LI_C (e)	0.312	-0.005	-0.113	0.061	-0.342
CPI (f)	-0.605^{+}	-0.115	0.325	-0.023	0.619^{+}
CMI (g)	-0.512^{+}	-0.151	0.296	0.030	0.551^{+}
NT (h)	-0.464	-0.823^{++}	0.675^{+}	0.671^{+}	0.446
N_L (i)	-0.616^{+}	-0.756^{++}	0.674^{+}	0.510^{+}	0.754^{++}
N_{NL} (j)	-0.433	-0.801^{++}	0.652^{+}	0.664^{+}	0.399
L_N (k)	-0.570^{+}	-0.583^{+}	0.568^{+}	0.319	0.730^{++}
LI_N (l)	-0.158	-0.480	0.486	0.290	-0.023
NPI (m)	-0.635^{+}	-0.240	0.418	0.049	0.676^{+}
NMI (n)	-0.613^{+}	-0.609^{+}	0.703^{+}	0.312	0.565^{+}

(a) TOC – total organic carbon, (b) C_L – labile carbon, (c) C_{NL} – non-labile carbon, (d) L_C – lability of carbon, (e) LI_C – index of carbon lability, (f) CPI – carbon pool index, (g) CMI – carbon management index, (h) NT – total nitrogen, (i) N_L – labile nitrogen, (j) N_{NL} – non-labile nitrogen, (k) L_N – lability of nitrogen, (l) LI_N – index of nitrogen lability, (m) NPI – nitrogen pool index, (n) NMI – nitrogen management index, $^{+}P < 0.05$, $^{++}P < 0.01$

(a) TOC – celkový organický uhlík, (b) C_L – labilný uhlík, (c) C_{NL} – nelabilný uhlík, (d) L_C – labilita uhlíka, (e) LI_C – index lability uhlíka, (f) CPI – index zdroja uhlíka, (g) CMI – uhlíkový riadiaci index, (h) NT – celkový dusík, (i) N_L – labilný dusík, (j) N_{NL} – nelabilný dusík, (k) L_N – labilita dusíka, (l) LI_N – index lability dusíka, (m) NPI – index zdroja dusíka, (n) NMI – dusíkový riadiaci index, $^{+}P < 0,05$, $^{++}P < 0,01$

Tabuľka 4 Korelácie medzi parametrami uhlíka a dusíka a zrnitostným zložením pôdy

Table 5 Correlations between the quantitative and qualitative parameters of soil organic matter and the particle size distribution of soil

	2.00 – 0.25 mm	0.25 – 0.05 mm	0.05 – 0.01 mm	0.01 – 0.001 mm	<0.001 mm
HA 1 (a)	-0.243	-0.311	0.516^{+}	-0.311	0.391
HA 2 (b)	-0.349	-0.109	0.176	0.085	0.385
HA 3 (c)	-0.317	-0.745^{++}	0.536^{+}	0.517^{+}	0.503^{+}
$\sum$HA (d)	-0.416	-0.421	0.440	0.171	0.544^{+}
FA 1a (e)	0.355	0.508^{+}	-0.510^{+}	-0.177	-0.466
FA 1 (f)	0.459	0.746^{++}	-0.640^{+}	-0.477	-0.567^{+}
FA 2 (g)	-0.300	-0.563^{+}	0.627^{+}	-0.007	0.469
FA 3 (h)	0.420	0.135	-0.138	-0.112	-0.607^{+}
$\sum$FA (i)	0.350	0.315	-0.171	-0.487	-0.382
$C_{HA} : C_{FA}$ (j)	0.191	-0.070	0.071	-0.357	0.098
C : N (k)	-0.512^{+}	-0.329	0.418	0.041	0.693^{+}
Q_{HS} (l)	0.481	0.540^{+}	-0.480	-0.247	-0.755^{++}
Q_{HA} (m)	0.430	0.261	-0.357	-0.029	-0.533^{+}

(a) HA 1 – humic acids free and bound with the mobile R_2O_3, (b) HA 2 – humic acids bound with Ca^{2+}, (c) HA 3 – humic acids bound with the mineral components of soil and stabile R_2O_3, (d) $\sum$ HA – sum of humic acids, (e) FA 1a – free aggressive fulvic acids, (f) FA 1 – fulvic acids free and bound with the mobile R_2O_3, (g) FA 2 – fulvic acids bound with Ca^{2+}, (h) FA 3 – fulvic acids bound with the mineral components of soil and stabile R_2O_3, (i) $\sum$ FA – sum of fulvic acids, $^{+}P < 0.05$, $^{++}P < 0.01$

(a) HA 1 – humínové kyseliny voľné a viazané s mobilnými R_2O_3, (b) HA 2 – humínové kyseliny viazané s Ca^{2+}, (c) HA 3 – humínové kyseliny viazané s minerálnymi zložkami pôdy a stabilnými R_2O_3, (d) $\sum$ HA – suma humínových kyselín, (e) FA 1a – voľné agresívne fulvokyseliny, (f) FA 1 – fulvokyseliny voľné a viazané s mobilnými R_2O_3, (g) FA 2 – fulvokyseliny viazané s Ca^{2+}, (h) FA 3 – fulvokyseliny viazané s minerálnymi zložkami pôdy a stabilnými R_2O_3, (i) $\sum$ FA – suma fulvokyselín, $^{+}P < 0,05$, $^{++}P < 0,01$

Tabuľka 5 Korelácie medzi kvantitatívnymi a kvalitatívnymi parametrami pôdnej organickej hmoty a zrnitostným zložením pôdy

nitrogen pool index (NPI), CMI and nitrogen management index (NMI) were also in positive correlation with the size fraction <0.001 mm (Table 4). In case of lower proportion of this fraction in soil, carbon and nitrogen contents are also lower, but changes in SOM are higher. The obtained results are consistent with the results of Barančíková (2002), who also describes that at lower values of CMI, stocks of organic carbon are subject to greater changes.

Higher quality of SOM (Table 5), according to the parameters of C : N ration, optical parameters of humus substances (Q_{HS}) and humic acids (Q_{HA}), ratio of humic acids carbon to fulvic acid carbon ($C_{HA} : C_{FA}$), were determined in arable land than in forest ecosystem. Wider $C_{HA} : C_{FA}$ ration was recorded on the arable land and fluctuated around 1. In case of forest ecosystem, except the Haplic Chernozem, however, the values were below 1, which shows dominance of fulvic acids.

Overall, higher extracted amounts of humic acids were on arable land and conversely, fulvic acids in forest. On the base of Q_{HS} and Q_{HA}, the humus substances extracted from arable land can be considered as more stabilized. Madari et al. (1998) found out that higher aromatisation of humic acids is in tillage soils than in no-tillage, as a result of stronger oxidizing conditions in soils, with constant mechanical disruption and subsequently faster decomposition of SOM, especially aliphatic parts of humic acids. Bayer et al. (2002) showed lower degree of humification of humic acids extracted from no-tillage systems than from conventional, which is the result of lower concentration of stabile semiquionones. The higher the intensity of tillage, the higher the stabilization of humus substances; and therefore their higher stability was recorded on arable land than in forest ecosystem.

The content of size fraction <0.001 mm was in positive correlation with the C : N ratio, and in negative with Q_{HS} and Q_{HA} (Table 5). This means, the higher content of size fraction of <0.001 mm was, the more stabilized were humus substances and humic acids.

Influence of size fraction <0.001 mm was showed also in relation to individual fractions of humus substances. The content of size fraction <0.001 mm was in positive correlation with the humic acid contents, mainly humic acids bound with the mineral components of soil and stabile R_2O_3 (HA 3) and in negative correlation with the free fulvic acids and bound with mobile R_2O_3 (FA 1) and with fulvic acids bound with mineral components of soil and stabile R_2O_3 (FA 3). On the other hand, these fractions of humic acids HA 3 and fulvic acids FA 1 were in opposite correlation with the size fraction 0.05 – 0.25 mm. This points to higher proportion of HA 3 in clay fraction (0.001 mm) and FA 1 in fine sand fraction (0.05 – 0.25 mm). Even according to Ellerbrock et al. (1999) extraction of humus substances is influenced also by the stability of clay itself.

It is interesting that the highest contents of humic acids bound with Ca^{2+} were on the fields, in which the cereals had the highest proportions. Conversely, the contents of fulvic acids bound with Ca^{2+} were the lowest just in the fields with the highest proportion of cereals.

Conclusion

The particle size distribution influenced quantity as well as quality of soil organic matter. The higher the content of smaller size fractions (<0.05 mm), the higher the content of soil organic matter; and it is subjected to smaller changes. The higher proportion of size fraction <0.001 mm was, the higher was stability of humus substances and humic acids, and humic acids bound with mineral components and stabile R_2O_3 were dominating. The amount of organic matter was higher in natural ecosystem, but its quality was higher in arable land.

Súhrn

Na štyroch pôdnych typoch (fluvizem, černozem, hnedozem, regozem) bol sledovaný vplyv zrnitostného zloženia pôdy na množstvo a kvalitu pôdnej organickej hmoty. Varianty zahŕňali pôdy lesného ekosystému, ktoré boli kontrolou a štyri rotácie plodín v agroekosystéme. Zastúpenie jednotlivých zrnitostných frakcií výrazne ovplyvnilo obsahy uhlíka a dusíka a frakčné zloženie humusových látok. Čím väčšie bolo zastúpenie menšej zrnitostnej frakcie (<0,001 mm), tým vyšší bol obsah pôdnej organickej hmoty (*r* = 0,794; *P* < 0,01), ktorá podliehala menším zmenám (*r* = 0,551; *P* < 0,05). Vyšší obsah frakcie do 0,001 mm podporil stabilitu humusových látok (*r* = -0,755; *P* < 0,01) aj humínových kyselín (*r* = -0,533; *P* < 0,05), pričom dominovali humínové kyseliny viazané s minerálnymi zložkami a stabilnými R_2O_3. Naopak vyšší obsah frakcie 0,05 – 0,25 mm prispel k vyššiemu obsahu fulvokyselín viazaných s mobilnými R_2O_3 a voľných fulvokyselín. Obsah organickej hmoty bol síce vyšší v prirodzenom ekosystéme, ale jej kvalita na ornej pôde bola lepšia.

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