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Original Paper

Green fallow soil vs. intensive soil cultivation – a study of soil structure along the slope gradient affected by erosion process

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The type of slope and its interaction with soil management practices are one of the most important factors affecting soil structure along the slope gradient. In this study, the effects of fallow in greening and intensive soil cultivation both located on slopes on changes soil properties especially soil structure were evaluated. Soil samples were collected from two fields (neighbouring fields) between Trakovice and Bučany villages (Slovakia). The terrain of both fields was sloping with a WN – ES orientation and a slope of <8°. Field 1 is used as arable land with intensive cultivation of crops (*IC*). In field 2, the fallow in greening (*G*) was established in 2012 and in 2018 soil samples were taken in five zones of both slopes as follows: on the summit slope, shoulder, back slope, toe slope and flat. Results showed that structure coefficient (*K*) was strongly affected by both land use ($p = 0.0000$) and slope position ($p = 0.0206$) as well as by the interaction of land use and slope position ($p = 0.0010$). The statistically significantly highest structure coefficient of water-stable aggregates (*Kwsa*) and opposite the lowest macro-aggregate destruction (*PAD*) were found for *G* compared to *IC*. In *G*, the index of crusting (Ic) increased by 9% compared to *IC*. The critical level of soil organic matter (S_t) was strongly affected by both land use ($p = 0.0114$) and slope position ($p = 0.0000$). The values of S_t were statistically significantly influenced by interaction of land use and slope position. When land use and slope position were assessed together, positive significant correlations were observed between silt and carbonate contents and Ic. On the other hand, the S_t values were strong effected soil organic matter (SOM) quantity and quality. In *IC*, positive correlations between C_L ($r = 0.773$, $P < 0.01$) and *K* were observed. Ic correlated with silt ($r = 0.650$, $P < 0.05$), carbonates ($r = 0.704$, $P < 0.05$) and lower humus stability. A higher silt and carbonate contents as well as higher content of SOM and better humus quality resulted in higher S_t values. In *G*, the *K* values positive correlated with silt and carbonate contents. Higher humus quality and stability improved soil structure evaluated on the base of *Kwsa*.

Keywords: intensive cultvation, greening, fallow, slope gradient, soil structure

1 Introduction

Soil degradation includes all of the processes leading to aggravation of soil quality and its productivity (Novák and Valla, 2002). One of the most important degradation processes in agricultural areas is soil erosion. It defined as a gradual process (occurring mostly in undulating terrain) consisting of removing soil particles under the impact of different external factors (water, wind, glacier etc.) causing the deterioration of soil. Water erosion constitutes a major global environmental problem threatening agricultural productivity, water quality, infrastructure etc. (Efthimiou, 2018). Moreover water soil erosion is considered as the process responsible for the biggest share of soil loss in Central European agricultural ecosystems (Panagos et al., 2015). Also in Slovakia the attention is paid rather to water than wind erosion when looking into the problem of potential soil loss. According to the outputs of last soil monitoring cycle (Kobza et al., 2017) in Slovakia about 39% of agricultural soils are potentially affected by water erosion (10% in medium, 15% in high and 14% in extremely high level). Regarding individual soil types, categories of extremely high to medium erosion predominates on soil types occurring at the mountainous and submountainous regions (Cambisols and Rendzic Leptosols) where about 75% of

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total area covered with these soil types can be affected by potential water erosion.

The degree of soil erodibility depends on both, soil properties and external factors such as: climate, topography, bedrock, land use, soil management practices etc. and their interrelationships (Morgan, 2005). Incorrect soil management associated with intensive crop production can significantly contribute to soil loss (Moreno-Ramón et al., 2014; Borrelli et al., 2015). The erosion rates in conventionally tilled cropland are on average one- to two-fold greater than the rates of soil production (Montgomery, 2007). It is a reason why implementing of green fallow management is important to be applied in Slovakia. Greening is a set of practices that are beneficial to the environment and climate protection. It consists mainly of crop rotation on arable land (at least three different crops). Very important element of this management type is the omission of the part of land which cannot be used for the crop production. This part of the field (or even the entire field) can be used for the green fallow.

One of the major causes of erosion in cropland is disrupting of soil structure, thus accelerating surface runoff and soil loss. Soil structure is one of the most important indicator of soil quality (Foth, 1990; Pires et al., 2017). The aggregation processes and aggregate stability are very important as the soil aggregate is a fundamental unit of soil structure (Foth, 1990). Aggregate stability depends on the content of base minerals and the type of clay minerals, soil organic matter, electrolyte concentration, texture, soil management practices etc. (Bronick and Lal, 2005; Šimanský et al., 2019). The soil structure have been studied previously in different soil types, climate conditions and under varying soil management practices (Šimanský et al., 2014; Bartlová et al. 2015; Šimanský and Jonczak, 2016; Šimanský et al., 2019). However, the soil structure parameters and their interactions with other soil properties under intensive cultivation and greening system in commercial setting and in field conditions in Slovakia has not been explored yet with few exceptions (Šimanský et al., 2019a). Thus the main assumptions of this study are that selected soil structure parameters depend on the slope position (up slope to down slope direction) and the management type (intensive cultivation and green fallow) what should be connected with changes in soil properties (higher soil organic matter content, higher content of clay, carbonates etc.). Soil structure is a complex system and one of the reasons for the complexity of soil structure is the range of scales it expresses. Structural processes occur at a scale ranging from a few Å (angström) to several centimeters (cm). Another cause of complexity is the dynamic nature of soil structure. Structural attributes vary in time and space, and the attributes observed at any given time reflect the net effect of numerous interacting factors that may change at any moment (Lal and Shukla, 2004), and is difficult to characterize (Coughlan et al., 1991). For comprehensive assessment of the soil is not suitable to indicate only one parameter. Except of soil structure, in order of responsible assessing the quality of the soil there also several soil properties (chemical, physical and SOM) have to be quantified. While previous research carried out by authors in this area (Šimanský et al., 2019a) concerned the influence of slope position and management type on selected soil properties including some of the soil structure parameters and soil organic matter properties this study is focused primarily on the interactions of land use and slope position and their impact on the soil structure indexes connected with vulnerability for the soil erosion. This paper can provide a good basis on topic of different soil management practices impact on soil structure properties and their association with soil loss, as well as the identification of the most erosion vulnerable areas in the study region.

2 Material and methods

Study site consists of two adjoining fields located are between villages Trakovice (48° 25′ 46.045″ N; 17° 42′ 20.87″ E) and Bučany (48°25′37.74″ N17° 42′ 16.24″ E) in the north-west part of Danube lowland. The sites have a temperate climate. The average monthly precipitation and temperatures is 634 mm and 9.7°C, respectively (http://www.climate-data.org). Geological substrates of the mentioned region are neogene clays, sands and gravels, mostly covered with loess (silts and silt loams). Several soil types dominates in the study area (Fluvisols, Chernozems, Luvisols, Kastanozems etc.; Fulajtár and Saksa, 2018).

The sampling was carried out within the two adjacent fields located on the slope in complex of Regosols and Chernozems. The terrain of both fields was sloping with a WN – ES orientation with inclination of <8°. Field 1 was used as arable land with intensive cultivation of crops (*IC*). In 2018 (sampling time) maize was planted in field 1. The maize lines were oriented in the slope direction (which is incorrect way) and the spacing was 70 cm apart. The field 2 was abandoned from 2012 and use as a part of greening (G) system (green follow). Weeds were mulched by cutting or disking twice a year. Both fields were divided into five zones for sampling: 1. summit (S), 2. shoulder (SH), 3. backslope (BS), 4. toe slope (TS), and 5. flat (F). In each zone, the soil pits (totally 10) were prepared and a soil samples (disturbed and undisturbed) from cultivated horizon (to the depth of 20 cm) were taken.

Several soil properties were determined in collected disturbed soil samples and described in the previous, above mentioned paper (Šimanský et al., 2019a). These properties were as follows: pH of the soil-to-solution ratio of 1 : 2.5 using H_2O as the suspension medium; content of soil organic carbon (SOC) by sample oxidation in the mixture of $K_2Cr_2O_7$ and H_2SO_4 (Dziadowiec and Gonet 1999); and content of carbonates by the volumetric method using a Jankov calcimeter. Particle-size distribution was determined by pipette method (Hrivňaková et al., 2011), texture classes were described according to USDA (Soil Survey Division Staff 1993). The labile carbon content (C_L) was determined using 0.005 mol/dm^3 $KMnO_4$ (Loginow et al. 1987) and hot water extracted carbon (C_{HWE}) was determined according to the method of Kőrschner et al. (1990). The group and fraction composition of humic substances (HS) was determined by the Belchikova and Kononova method (Dziadowiec and Gonet 1999). The irradiation absorbance of humic substances (HS) and humic acids (HA) was measured at 465 and 650 nm using a Jenway 6400 Spectrophotometer to calculate the colour quotients Q_{HS} and Q_{HA}. Undisturbed soil samples were sieved by dry sieving as dry sieved aggregates as well as by wet sieving as water-stable aggregates – Baksheev method (Vadjunina and Korchagina, 1986). Individual size fractions of both dry and wet sieved aggregates were used for calculation of structure coefficient for dry sieving (K) as well as for wet sieving (*Kwsa*) (Fulajtár 2006). We also calculated the percentage of aggregate destruction (*PAD*) (Zhang and Horn, 2001), index of crusting (I_c) and critical level of soil organic matter (S_t) (Lal and Shukla, 2004).

The experimental results were compared and analysed in terms of its variability following both land use types and slope positions. Multifactor analysis of variance (ANOVA) and Fisher's least significant difference (LSD) tests were used to compare above-mentioned factors. All results were reported at $\alpha = 0.05$ level of significance. Regression analyses were used to establish the relationships between parameters of soil structure and texture, carbonate contents and soil organic matter parameters. The coefficient of determination (R^2) was used to evaluate the performance of the applied regression equations. All statistical analyses were performed using the Statgraphics Centurion XV.I (Statpoint Technologies, Inc., USA).

3 Results and discussion

On the intensively cultivated slope (*IC*) content of silt and clay increased along the slope gradient. Different pattern was observed on the slope used as the green fallow (G), where the sand content increased and silt content decreased from the summit to the lower parts of the slope. In both different used slopes the particle size distribution was very similar. Soil texture was silt loam, with the clay content ranging from 14% to 22% (Šimanský et al., 2019a). As reported Bronick and Lal (2005) soil texture has a significant effect on aggregation as well as other soil properties such as soil organic matter, carbonate content and etc. (Šimanský et al., 2014; Paradelo et al., 2013). In previous paper (Šimanský et al., 2019a) dependencies between soil organic matter

Table 1 Dependencies between the soil structure parameters, land use type and slope position

	K		*Kwsa*		*PAD*		I_c		S_t	
Land use										
Intensive cultivation	1.27		1.20		27.3		1.22		3.02	
Green fallow	2.29		2.36		16.4		1.11		3.10	
P-value	0.0000		0.0056		0.0009		0.0000		0.0114	
Slope position										
	intensive cultivation	green fallow	intensive cultivation	green fallow	intensive cultivation	green fallow	intensive cultivation	green fallow	intensive cultivation	green fallow
Summit	1.21	2.57	0.81	1.34	40.5	23.0	1.24	1.06	3.07	3.05
Shoulder	1.06	2.74	1.14	1.26	26.6	28.5	1.50	1.43	2.57	1.68
Backslope	1.78	1.99	0.93	1.25	42.0	22.8	1.11	1.13	3.32	2.72
Toe slope	1.21	2.29	1.84	4.28	11.0	5.50	1.16	1.04	3.36	3.70
Flat	1.08	1.85	1.25	3.69	16.5	2.44	1.09	0.91	3.17	3.94
P-value	0.0206		0.0089		0.0001		0.0000		0.0000	
Land use × Slope position										
P-value	0.0010		0.1117		0.0790		0.0000		0.0000	

K – structure coefficient, *Kwsa* – structure coeficient of water-stable aggregates, *PAD* – percentage of macro-aggergate destruction, I_c – index of crusting, S_t – critical level of soil organic matter parameters, carbonate content and land use as well as the slope gradient have been studied, and now our attention was focused on soil structure parameters.

The actual structural state of soils based on structure coefficient (*K*) was strongly affected by both land use ($p = 0.0000$) and slope position ($p = 0.0206$). The interaction of land use and slope position had a strong tendency ($p = 0.0010$) to affect the actual structure state while the effect of land use type seemed be more pronounced than slope position (Table 1). Shein (2005) considered the *K* values ranging from 0.67 to 1.50 as favourable and *K* values lower than 0.67 as unfavourable structural state. In our case (in both land use and all slope position) the *K* values ranged from 1.60 to 2.74. Higher values represented better soil structure development (Šimanský et al., 2018). *K* values were about 82% higher on the slope used as the green fallow when comparing to intensively cultivated slope. Taking into account the slope position, *K* values indicated the worst actual structural state in flat (*F*) terrain under the slopes no matter the land use type. These results confirm the previous statements (Šimanský, 2011) as due to the erosion non-stabile aggregates (especially lower in size) are transported down along the slope and formation of stable soil structure depend on both external and internal factors (Amézketa, 1999; Bronick and Lal, 2005; Wiesmeier et al., 2012; Burdukovskii et al., 2019). When comparing the *K* values individually with dependence on land use and slope position, the effects differ depending on the slope form (Figure 1A). The *K* dynamics along the slope gradient from the upper to lower slope positions ($p > 0.05$) have been expressed by quadratic polynomial trend in the best way (Table 2). Except actual structure state of soil (based on *K* values) water-stability of soil structure is very important to pay the attention because the ability of soil aggregates against water destruction is very significant especially from viewpoint of soil erosion (Six et al., 2004). The multifactor ANOVA analysis showed

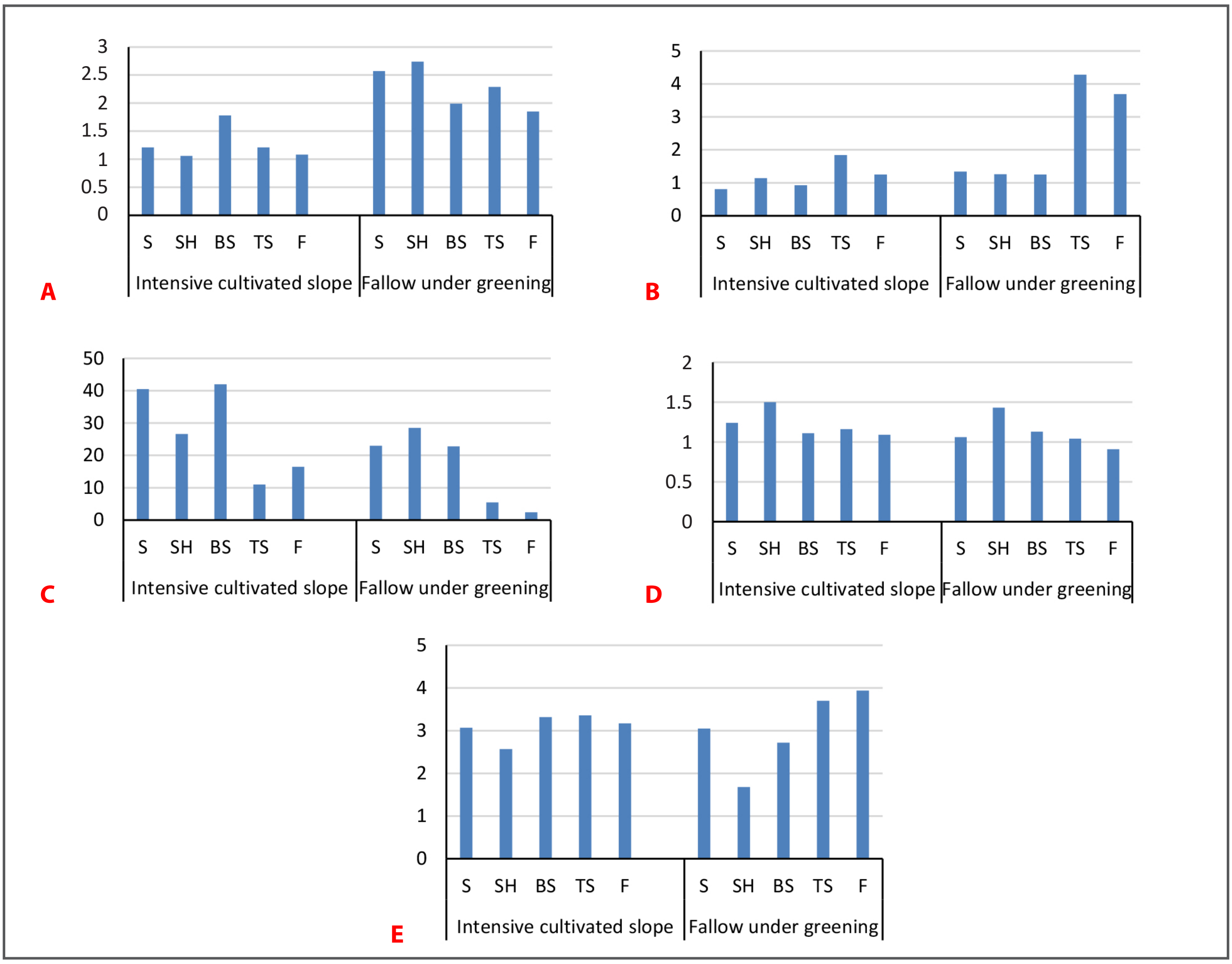

Figure 1 Soil structure parameterst along the slope gradient under intenisve cultivated slope and fallow under greening
A – structure coefficient, B – structure coeficient of water-stable aggregates, C – percentage of macro-aggergate destruction, D – index of crusting, E – critical level of soil organic matter
Notes: S – summit, SH – shoulder, BS – backslope, TS – toe slope, F – flat

significant differences between land use types in case of *Kwsa* ($P = 0.0056$) and *PAD* ($P = 0.0009$). The significant differences between slope positions for *PAD* ($P = 0.0001$) were also noted. The statistically significantly highest *Kwsa* values and opposite – the lowest percentage of macro-aggregate destruction (*PAD*) values were found for *G* compared to *IC* in terms of different land use type. Soils under the green fallow management as published Šimanský (2018) and Burdukovskii et al. (2019) have a significantly better developed structure than soils of intensively cultivated fields. There were no significant interactions between land use and slope position (Table 1).

Under both management types *G* and *IC* distinctive pattern have been observed. The highest *Kwsa* as well as the lowest *PAD* values were determined for samples collected from the lowest positions of the slopes (TS and F, Figure 1B and 1C). Although only in the *G* on the slope did the *PAD* show a statistically significant quadratic polynomial trend (Table 2) along the slope gradient (from the upper to the lower parts of the slope). The index of crusting (I_c), based on textural composition and soil organic matter content (Lal and Shukla, 2004), is a very important parameter of soil structure, as it is inversely related to clay and soil organic matter content, and directly to fine and coarse silt content. Formation of the soil crust depend on soil tillage and fertilization (Šimanský et al., 2008), as well as on the presence of sufficient supply of organic matter in soil (Špička et al., 1964; Šimanský et al., 2014). Soil under the green fallow was characterized with higher values of I_c (about 9% higher) when compared to intensive cultivation on the slope. Ic were also strongly affected by slope position ($p = 0.0000$). In both analysed slopes (*G* and *IC*), the highest I_c values were observed at SH position while the lowest at the flat terrain under the slope (Figure 1D). This results are surprising as we expected the highest formation of soil crust in flat terrain and the lowest values on the upper parts of the slope due to erosion processes. However, any statistically significant trend in I_c dynamics along the slope gradient in both *G* and *IC* were not observed (Table 2). The interaction of land use and slope position showed a strong tendency ($p = 0.0000$) to affect I_c values. The impact of the land use type tended to be more pronounced than slope position (Table 1). Critical soil organic matter content (S_t) according to Pieri (1991) is another important parameters of soil structure stability as the soil structure is significantly affected by soil organic matter content (Bronick and Lal, 2005; Czachor et al., 2015; Šimanský and Jonczak, 2016). The S_t was strongly affected by both land use type ($p = 0.0114$) and slope position ($p = 0.0000$). The values of S_t were statistically significantly dependent on the interaction of land use and slope position (Table 1). The most stable soil structure according to determined S_t values were observed at TS and F positions of slopes under both of

Table 2 Trends of soil structure parameters along the slope gradient

Land use	Soil structure parameter	Model	R^2
Intensive cultivation	*K*	$y = -0.0893x^2 + 0.5247x + 0.676$ (Quadratic polynomial)	0.3247
	Kwsa	$y = 0.8203x^{0.349}$ (Power model)	0.4972
	PAD	$y = 53.941e^{-0.268x}$ (Exponential)	0.5330
	I_c	$y = 1.4139e^{-0.051x}$ (Exponential)	0.3964
	S_t	$y = -0.0064x^2 + 0.1376x + 2.756$ (Quadratic polynomial)	0.2448
Fallow under greening	*K*	$y = -0.0121x^2 - 0.1161x + 2.77$ (Quadratic polynomial)	0.6365
	Kwsa	$y = 0.1443x^2 - 0.0937x + 1.058$ (Quadratic polynomial)	0.6994
	PAD	$y = -2.0514x^2 + 5.8966x + 21.324$ (Quadratic polynomial)	0.8631
	I_c	$y = -0.0564x^2 + 0.2696x + 0.926$ (Quadratic polynomial)	0.6141
	S_t	$y = 0.2257x^2 - 0.9743x + 3.458$ (Quadratic polynomial)	0.6751

K – structure coefficient, *Kwsa* – structure coeeficient of water-stable aggregates, *PAD* – percentage of macro-aggergate destruction, I_c – index of crusting, S_t – critical level of soil organic matter

Table 3 Correlation coefficients between soil parameters on the analysed slopes

	Sand	Silt	Clay	$CaCO_3$	pH	SOC	CL	C_{HWD}	CHS	CHA	CFA	HA : FA	QHS	QHA
Intensive cultivation														
K	0.185	-0.366	0.281	-0.171	-0.239	0.455	0.773*	0.049	0.582	0.318	0.665*	-0.629	-0.329	-0.308
Kwsa	-0.321	0.319	0.047	-0.597	-0.459	0.475	0.276	0.228	0.403	0.655*	0.163	0.216	-0.477	-0.529
PAD	0.484	-0.415	-0.184	0.589	0.455	-0.347	0.038	0.073	-0.173	-0.499	0.079	-0.416	0.357	0.394
I_c	-0.185	0.650*	-0.763*	0.704*	0.882***	-0.888***	-0.400	0.100	-0.852**	-0.698*	-0.814**	0.592	0.915***	0.882***
S_t	0.305	0.641*	0.528	0.660*	0.809**	0.908***	0.582	0.218	0.953***	0.766**	0.922***	0.685*	-0.946***	-0.936***
Green fallow														
K	-0.798**	0.841**	0.412	0.556	0.509	-0.567	-0.546	-0.591	-0.614	-0.624	-0.555	-0.537	0.605	0.520
Kwsa	-0.686*	-0.524	-0.826**	-0.618	-0.649*	0.676*	0.658*	0.700*	0.649*	0.677*	0.554	0.536	-0.734*	-0.860**
PAD	-0.877***	0.767**	0.824**	0.769**	0.799**	-0.838**	-0.842**	-0.856**	-0.855**	-0.864**	-0.783**	-0.619	0.868**	0.935***
I_c	-0.897***	0.912***	0.542	0.942***	0.890***	-0.965***	-0.959***	-0.903***	-0.973***	-0.952***	-0.951***	-0.658*	0.909***	0.747*
S_t	0.925***	-0.868**	-0.731*	-0.961***	-0.953***	0.993***	0.974***	0.915***	0.993***	0.988***	0.939***	0.712	-0.974***	-0.892***
Bothl land use types evaluated together														
K	-0.330	-0.111	0.719***	-0.511*	-0.493*	-0.241	-0.277	-0.431	-0.110	-0.068	-0.165	-0.029	-0.296	-0.429
Kwsa	0.361	-0.422	0.025	-0.640**	-0.649**	0.536*	0.437	0.399	0.604**	0.680***	0.392	0.541*	-0.642**	-0.680***
PAD	-0.139	0.259	-0.153	0.719***	0.684***	-0.510*	-0.346	-0.280	-0.553*	-0.638**	-0.334	-0.564*	0.646**	0.672**
I_c	-0.541*	0.816***	-0.312	0.765***	0.828***	-0.829***	-0.661**	-0.433	-0.860***	-0.813***	-0.824***	-0.305	0.903***	0.797***
S_t	0.745***	-0.673**	-0.243	-0.486*	-0.557*	0.981***	0.909***	0.767***	0.974***	0.927***	0.920***	0.411	-0.714***	-0.570**

K – structure coefficient, *Kwsa* – structure coeeficient of water-stable aggregates, *PAD* – percentage of macro-aggergate destruction, I_c – index of crusting, S_t – critical level of soil organic matter, $CaCO_3$ – carbonate contents, pH – soil pH, SOC – soil organic carbon, C_L – labile carbon, C_{HWD} – hot water extracted carbon, CHS – humic substances carbon, CHA – humic acids carbon, CFA – fulvic acids carbon, Q_{HS} – colour quotients of humic substances, Q_{HA} – colour quotients of humic acids the examined land use types (Figure 1E). Despite the fact of any statistical significance the S_t dynamics is quite well expressed by the quadratic polynomial trend (Table 2).

The relationships between the soil structure parameters and texture as well as SOM were evaluated as shown in Table 3. The soil structure is affected by many factors (Amézketa, 1999; Bronick and Lal, 2005; Wiesmeier et al., 2012; Czachor et al., 2015; Šimanský and Jonczak, 2016; Šimanský et al., 2019), what has been confirmed with our findings. However, obtained results clearly show that not every factor influencing soil structure was influenced the same way. Many significant interactions were observed between investigated parameters. When samples from both land use types and all slope positions were assessed together, positive significant correlations were observed between silt and carbonate contents and I_c, while SOM and organic matter parameters did not have any effect on formation of soil crust what is surprising because as it was reported by Špička et al. (1964) and Maïga-Yaleu et al. (2013) as well as Šimanský et al. (2014) higher SOM content impede formation of soil crust. On the other hand, the S_t values were strong effected SOM quantity and quality. We also determined better soil structure state (based on S_t) with higher humus stability (Table 3). Differences were noted when the relationships were assessed separately depending on the land use. For instance, in *IC*, positive correlations between labile carbon ($r = 0.773$, $P < 0.01$), carbon of fulvic acids ($r = 0.665$, $P < 0.05$) and *K* were observed. Soil crust formation have been supported by higher contents of silt, carbonates and lower humus quality and stability. A higher silt and carbonate contents as well as higher content of SOM and better humus quality resulted in higher S_t values in intensive cultivation on the slope. In general, tillage disturbance has been recognized as one of the major causes of erosion. The erosion rates in conventionally tilled cropland are on average one- to two-fold greater than the rates of soil production (Montgomery, 2007). Reduction of soil tillage improves soil properties including texture, structure and organic matter content (Ba et al., 2016). Overall, the highest number of statistically significant correlations between soil structure parameters and texture as well as SOM parameters were observed in soil under green fallow than on intensively cultivated slope (Table 3). In *G*, the *K* values positively correlated with silt and carbonate contents. In opposite, SOM parameters did not affect the *K* values. Higher labile carbon content as well as higher humus quality and stability improved soil structure development evaluated on the base of *Kwsa* on *G* slope. Aggregate destruction (*PAD*) was more intensive due to higher sand and carbonate contents as well as due to lower humus stability. In *G*, formation of soil crust have been supported by higher silt and carbonate contents and on the other hand also by lower humus stability. With higher contents of silt, clay and SOM values of S_t were increasing.

Conclusions

Based on the results of this study we proved that the selected soil structure parameters of silt loam soil was different due to both: the land use type and the slope position. Moreover, it can be concluded that not all of the examined soil structure parameters were equally influenced by pedogenic factors. The assumption that the soil structure could be affected by the interactions between internal and external factors has been confirmed. Overall, the highest number of statistically significant correlations between soil structure parameters and texture as well as SOM parameters were observed in the green fallow than in intensive cultivation on the slope. The results indicate that land use can significantly affect the relationships between texture, SOM and soil structure development.

References

AMÉZKETA, E. (1999) Soil aggregate stability: a review. In *J. of Sustain. Agric.*, vol. 14, no. 2–3, pp. 83–151. doi: http://dx.doi.org/10.1300/J064v14n02_08

BA, L.T. et al. (2016) Effect of cropping system on physical properties of clay soil under intensive rice cultivation. In *Land Degrad. Dev.*, vol. 27, pp. 973–982. doi: https://doi.org/10.1002/ldr.2321

BARTLOVÁ, J. et al. (2015) Water stability of soil aggregates in different systems of tillage. In *Soil & Water Res.*, vol. 10, pp. 147–154.

BORRELLI, P. et al. (2015) Modelling post-tree-harvesting soil erosion and sediment deposition potential in the Turano river basin (Italian central Apennine). In *Land Degrad. Dev.*, vol. 26, pp. 356–366. doi: https://doi.org/10.1002/ldr.2214

BRONICK, C.J. and LAL, R. (2005) Soil structure and management: a review. In *Geoderma*, vol. 124, pp. 3–22. doi: http://dx.doi.org/10.1016/j.geoderma.2004.03.005

BURDUKOVSKII, M. et al. (2019) Impact of different fallow durations on soil aggregate structure and humus status parameters. In *Soil and Water Research* (in press).

COUGHLAN, K.J. et al. (1991) Measurement of soil structure: Some practical initiatives. In *Aust. J. Soil Res.*, vol. 29, no. 6, pp. 869–889. DOI: http://dx.doi.org/10.1071/SR9910869

CZACHOR, H. et al. (2015) Impact of long-term mineral and organic fertilizer application on the water stability, wettability and porosity of aggregates obtained from two loamy soils. In *Eur. J. Soil Sci.*, vol. 66, pp. 1–12. doi: https://doi.org/10.1111/ejss.12242

DZIADOWIEC, H. and GONET, S. S. (1999) *Methodical guide-book for soil organic matter studies.* Prace Komisji Naukowych Polskiego Towarzystwa Gleboznawczego, N. 120, Komisja chemii gleb, Zespół Materii Organicznej Gleb, N II/16 (in Polish).

EFTHIMIOU N. (2018) The importance of soil data availability on erosion modeling. In *Catena*, vol. 165, pp. 551–566. doi: https://doi.org/10.1016/j.catena.2018.03.002

FOTH, H.D. (1990) *Fundamentals of soil science*. New York: John Wiley and Sons, pp. 360. ISBN 0-471-52279-1.

FULAJTÁR, E. (2006) *Physical properties of soi*l (in Slovak). Bratislava: VÚPOP, pp.142. ISBN 80-89128-20-3.

FULAJTÁR, E. and SAKSA, M. (2018) Loess soils of the Trnava Hilly Land. In ŚWITONIAK, M. and CHARZYŃSKI, P. *Soil Sequences Atlas IV*. Toruń: Nicolaus Copernicus University, pp. 123–137. ISBN 978-83-951878-2-7.

HRIVŇAKOVÁ, K. et al. (2011) *Uniform methods of soil analyses* (in Slovak) VUPOP: Bratislava.

KOBZA, J. et al. (2017) Current state and development of land degradation processes based on soil monitoring in Slovakia. In *Agriculture* (Poľnohospodárstvo), vol. 63, no. 2, pp. 74–85. doi: ow soils after 80 years of continuous fertilizer addition. In *Geoderma*, vol. 200–201, pp. 40–44. doi: https://doi.org/10.1515/agri-2017-0007

KÖRSCHNER M. et al. (1990) Heisswasserlőslicher C und N im Boden als Kriterium fűr das N-Nachliferungsvermőgen. In *Mikrobiologie*, vol. 145, pp. 305–311.

LAL, R. and SHUKLA, M.K. (2004) *Principles of soil physics*. New York: Marcel Dekker. ISBN 0-8247-5324-0.

LOGINOW, W. et al. (1987) Fractionation of organic carbon based on susceptibility to oxidation. In *Pol. J. Soil Sci.*, vol. 20, pp. 47–52.

MAÏGA-YALEU, S. et al. (2013) Soil crusting impact on soil organic carbon losses by water erosion. In *Catena*, vol. 107, pp. 26–34. doi: http://dx.doi.org/10.1016/j.catena.2013.03.006

MONTGOMERY, D.R. (2007) Soil erosion and agricultural sustainability. In *PNAS*, vol. 104, pp. 13268–13272. doi: https://doi.org/10.1073/pnas.0611508104

MORENO-RAMÓN, H. et al. (2014) Coffee husk mulch on soil erosion and runoff: experiences under rainfall simulation experiment. In *Solid Earth*, vol. 5, pp. 851–862. doi: https://doi.org/10.5194/se-5-851-2014

MORGAN, R.P.C. (2005) *Soil Erosion and Conservation*. 3rd ed. London: Blackwell Publishing, pp. 299.

NOVÁK, P. and VALLA, M. (2002) Other degradation forms of soil. In *Pedologické dny*, 2002, pp. 137–142.

PANAGOS, P. et al. (2015) Rainfall erosivity in Europe. In *Sci. Total Environ.*, vol. 511, pp. 801–814. doi: http://dx.doi.org/10.1016/j.scitotenv.2015.01.008

PARADELO, R. et al. (2013) Water-dispersible clay in bare fallow soils after 80 years of continuous fertilizer addition. In *Geoderma*, vol. 200–201, pp. 40–44. doi: https://doi.org/10.1016/j.geoderma.2013.01.014

PIERI, C. (1992) *Fertility of Soils: A Future for Farming in the West African Savannah*. Berlin: Springer-Verlag, pp. 347. ISBN 978-3-642-84322-8.

PIRES, L.P. et al. (2017) Soil structure changes induced by tillage systems. In *Soil Tilage Research*, vol. 165, pp. 66–79. doi: https://doi.org/10.1016/j.still.2016.07.010

SHEIN, E. V. (2005) *Course of Soil Physics.* Moscow: MGU, pp. 432. ISBN 5-211-05021-5 (in Russian).

SIX, J. et al. (2004) A history of research on the link between (micro)aggregates, soil biota, and soil organic matter dynamics. In *Soil Till Res.*, vol. 79, pp. 7–31. doi: https://doi.org/10.1016/j.still.2004.03.008

ŠIMANSKÝ, V. (2011) Soil structure of Haplic Luvisol as influenced by tillage and crop residues ploughing. In *Acta fytotechnica et zootechnica*, vol. 14, no 1, pp. 27–29.

ŠIMANSKÝ, V. and JONCZAK, J. (2016) Water-stable aggregates as a key element in the stabilization of soil organic matter in the Chernozems. In *Carpathian Journal of Earth and Environmental Sciences*, vol. 11(2), pp. 511–517.

ŠIMANSKÝ, V. et al. (2008) Soil tillage and fertilization of Orthic Luvisol and their influence on chemical properties, soil structure stability and carbon distribution in water-stable macro-aggregates. In *Soil Till. Res.*, vol. 100, no. 1–2, pp. 125–132. doi: http://dx.doi.org/10.1016/j.still.2008.05.008

ŠIMANSKÝ, V. et al. (2014) Soil crust in agricultural land. In *Acta fytotechnica et zootechnica*, vol. 17, no 4, pp. 109–114. doi: https://doi.org/10.15414/afz.2014.17.04.109–114

ŠIMANSKÝ V. (2018) Can soil properties of Fluvisols be influenced by river flow gradient? In *Acta fytotechnica et zootechnica*, vol. 21, no 2, pp. 63–76. doi: https://doi.org/10.15414/afz.2018.21.02.63-76

ŠIMANSKÝ, V. et al. (2018). *Soil Science.* Nitra: SPU, pp. 399. ISNB 978-80-552-1878-6 (in Slovak).

ŠIMANSKÝ, V. et al. (2019) How relationships between soil organic matter parameters and soil structure characteristics are affected by the long-term fertilization of a sandy soil. In *Geoderma*, vol. 342, pp. 75–84. doi: https://doi.org/10.1016/j.geoderma.2019.02.020

ŠIMANSKÝ, V. et al. (2019a) Slope position and management practices as factors influencing selected properties of topsoil. In *Soil Science Annual* (in press).

ŠPIČKA, A. et al. (1964) *Soil properties and processing.* Praha: SZN (in Czech).

VADJUNINA, A.F. and KORCHAGINA, Z.A. (1986) *Methods of Study of Soil Physical Properties.* Moscow: Agropromizdat (in Russian).

WIESMEIER, M. et al. (2012) Aggregate stability and physical protection of soil organic carbon in semi-arid steppe soils. In *European Journal of Soil Science*, vol. 63, pp. 22–31. doi: https://doi.org/10.1111/j.1365-2389.2011.01418.x

ZHANG, B. and HORN, H. (2001) Mechanisms of aggregate stabilization in Ultisols from subtropical China. In *Geoderma*, vol. 99, pp. 123–145. doi: https://doi.org/10.1016/S0016-7061(00)00069-0