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THE INFLUENCE OF DIFFERENT TECHNOLOGIES OF SOIL PROCESSING ON INFILTRATION PROPERTIES OF SOIL IN THE CAMBISOLS AREA OF THE OPAVA DISTRICT

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Abstract

DUMBROVSKÝ MIROSLAV, LARIŠOVÁ LUCIE. 2016. The Influence of Different Technologies of Soil Processing on Infiltration Properties of Soil in the Cambisols Area Of The Opava District. *Acta Universitatis Agriculturae et Silviculturae Mendelianae Brunensis,* 64(5): 1495–1505.

The subject of the contribution is the evaluation of the influence of the conventional tillage and reduced tillage technology of soil processing on the infiltration properties of the soil in the Větřkovice area. Field experimental work at the area was carried out in the years 2013–2015 on Cambisol district medium-heavy clayey soil. The research was conducted on sloping erosion-endangered blocks of arable land sown with spring barley. The areas were chosen each year in the way that one of the experimental areas was handled by conventional tillage technologies and the other by reduced tillage technologies. Intact soil samples were taken into Kopecký's cylinders in the three landscape positions, at a depth of 10 cm (representing topsoil) and 30 cm (representing subsoil). The cumulative infiltration was measured using a mini-disc infiltrometer near the consumption points. The Zhang method (1997), which provides an estimate of the unsaturated hydraulic conductivity *K(h),* was used for the evaluation of the infiltration tests of the mini-disc infiltrometer.
The soil profile processed by conventional tillage showed a higher degree of compaction. The bulk density was between 1.10–1.67 g.cm^{-3}, compared to the land processed by the reduced tillage technology, where the values were between 0.80–1.29 g.cm^{-3}.
Unsaturated hydraulic conductivity values were about one-third higher within the reduced tillage technology soil processing.

Keywords: soil processing, unsaturated hydraulic conductivity, cumulative infiltration, bulk density, porosity

INTRODUCTION

The infiltration characteristic of the soil surface is one of the major factors that determines the potential soil erosion risk. The infiltration soil ability has an important role in soil protection. Lack of infiltration characteristics of the soil surface, however, limit the soaking of the water into the soil, which, in combination with the high intensity of rainfall, can cause the formation of surface runoff and with that associated negative erosion phenomena. Infiltration is affected by a number of factors, which can be classified into four groups – soil characteristic (structure, texture, physical, chemical and humidity parameters), the characteristic of the soil surface (e.g., soil crust), way of farming on soil (soil processing technology, the type of vegetation cover) and natural conditions (the quantity and intensity of rainfall, temperature, soil moisture) (Lukas *et al.*, 2007).

Farming on soil has the greatest influence on the landscape in the agriculturally used landscape.

Processing soil technology can be divided into two basic groups, i.e. conventional tillage with ploughing and reduced tillage where ploughing is excluded. The main reasons for the application of reduced tillage technologies consist in economic and ecological areas (Titi, 2002).

The physical, chemical and biological characteristic of soil is changed by the processing of soil. Each technological intervention in land defragments the soil particles and changes the ir spatial arrangement (Hadas, 1997). Soil structure is one of the factors affecting infiltration (Truman and Franzmeier, 2006). The structural soil condition, together with the processing of the soil, is related to water detention in the soil (Gajic *et al.*, 2004).

Lichner *et al.* (2004) state that, in the course of the growing season, the soil water regime consists of alternating phases: accumulation and percolation. The water infiltrating from precipitation is accumulated in the soil profile and is used by plants during transpiration. This phase usually lasts a few weeks. If consumption of water on transpiration exceeds rainwater inflow, water from the soil is drawn to the lower boundary value when the lack of water in the soil causes transpiration to stop. However, if the rainwater exceeds its consumption on transpiration, infiltrating water fills the soil up to the moment when the volume of accumulated water exceeds a certain amount. The n a sudden outflow of a large amount of water into the subsoil occurs. This starts the percolation phase, in which most of the water flows through the soil to the subsoil without being intercepted in the soil. The duration of the percolation phase is dependent on the withholding activity and the volume of water in the soil during its start-up and may last from several hours to several days or weeks.

This study assesses the influence of conventional tillage and reduced tillage soil technology on the soil infiltration for the period between 2013 and 2015. The actually soil moisture, the bulk density, soil porosity, unsaturated hydraulic conductivity and the cumulative infiltration measured by the mini-disc infiltrometer are compared.

MATERIALS AND METHODS

Experimental research was conducted in the cadastral territory of the municipality Větřkovice, the Vítkov district, the Moravian-Silesian region. The municipality belongs to a slightly warm region, cold district. This area is characterised by a climate with a very short, slightly cold and wet summer, a long transitional period with a slightly cold spring and a mild autumn, a long mild to slightly damp winter with a long duration of snow cover. The subsoil area consists of culm, greywacke and shale. The representation of the major soil units (MSU) in the cadastral territory is 26 brown soil of MSU, brown acid soil and their slightly gleysol forms on different slate and similar rocks; medium-hard, exceptionally harder, usually crushed stone with good moisture ratios up to over-moisturised.

The experimental areas have been selected on sloping, erosion-endangered blocks of arable land with different processing technology. For the localization of the most suitable sampling sites, erosion wash was calculated using the universal equation of Wischmeier-Smith based on the digital model of terrain (DMT) by the USLE 2D method using an LS algorithm according to McCool's (McCool *et al.*, 1987; McCool, *et al.*, 1898) for each of the experimental area. The infiltration tests were

1: *Experimental areas*

carried out in places with the greatest danger of soil water erosion and intact soil samples were collected.

Sampling was conducted in 2013–2015, always at the beginning, in the middle and at the end of the growing season. The experimental areas were sown with spring barley. In each year, two experimental areas were selected so that one area was processed by the conventional tillage technology of soil processing (ploughing to a depth of 22 cm) and reduced tillage technology of soil processing (autumn undermining to a depth of 20 cm).

In the context of the experimental research, infiltration tests were carried out on surfaces and selected physical soil characteristics were tracked, which are important for infiltration processes. A Decagon Device Inc. mini-disc infiltrometre was used for infiltration test.

2: *Mini Disk Infiltrometer*

The cumulative infiltration, measured by the Mini Disc Infiltrometer, was evaluated by the Zhang method *(1997)*. *Zhang (1997)* suggested, in his study, the following two-parametrical mathematical solutions to the description of infiltration processes under the infiltrometer in various infiltration times.

$$I = C_1 t^{1/2} + C_2 t \tag{1}$$

where

C_1 parameter of unsaturated hydraulic conductivity (m. s^{-1})

C_2 parameter of soil sorptivity (m.$s^{-1/2}$)

According to Zhang (1997), we can get unsaturated hydraulic conductivity of the relation

$$K(h) = \frac{C}{A} \tag{2}$$

where

h tension value (h) ≤ 0

C parameter of unsaturated hydraulic conductivity (m. s^{-1})

A dimensionless coefficient, which is variable with the total infiltration time

According to Van Genuchten's equations (1990), parameter values A_2 for 12 basic soil texture classes have been established, and for a different adjustable tension value of infiltrometer h_0 for the curcular Mini Disc Infiltrometer.

The tabular processing of parameter A is described in detail in the manual for the Mini Disc infiltrometer (Decagon, 2014).

In this study, unsaturated hydraulic conductivity for the calculation of the values of the parameters were used and taken from the manual to the Mini Disc infiltrometer (Decagon, 2014) for clay soil: A (–2 cm) = 6.4, α = 0.036, n = 1.56.

RESULTS AND DISCUSSION

Experimental research took place in the years 2013–2015. 55 sets of measuring infiltration were carried out. The measurement took place in May, June, July and August. The cumulative infiltration was measured using a Decagon Device, Inc. Mini Disc Infiltrometer.

Soil samples from a depth of 10 cm (representing topsoil) and 30 cm (representing subsoil) were collected into a Kopecký's cylinder of a volume V = 100 cm^3 for the research of the basic physical properties. The research was conducted on sloping land. Therefore, the samples were taken in the three positions of the slope of the landscape. The analyses were carried out by standard methodology in the laboratory of the Institute of Water Landscape Management of VUT FAST.

In each experimental point, three samples from the topsoil layer, three samples from subsoil layer and three infiltration tests were taken because of the statistical evaluation for each experimental point.

In the paper are the tabular processed values of the fundamental physical soil properties, in particular, the actually soil moisture, because the infiltration is in its initial phase features of actually soil moisture, then the bulk density and porosity are reduced. These physical properties point to the degree of the soil profile compaction, which affects soil infiltration.

For the evaluation of the structural condition of the soil, it is possible to track changes in volume weight and porosity over time. Lhotský (1984) states the critical values of the bulk density and soil porosity depending on the soil type. These critical values express the soil compaction.

From the tables, it is evident that the value of the bulk density exceeds the critical value of g.cm^{-3} 1.45 set by Lhotský (1984) on the land

I: *a,b – The basic physical properties of the tested surfaces of the Větřkovice area, conventional tillage and reduced tillage technologies in the years 2013–2015*

	Conventional tillage technology – upper part of the slope																	
Date	15.6.2013		31.5.2014		1.6.2015		19.7.2013		4.7.2014		3.7.2015		3.8.2013		2.8.2014		1.8.2015	
Depth	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30
ρ_d	1.53	1.35	1.10	1.26	1.05	1.12	1.55	1.37	1.41	1.46	1.10	1.15	1.58	1.42	1.47	1.50	1.23	1.29
θ	33.2	34.2	19.6	20.9	11.5	12.4	13.5	14.2	21.37	21.56	8.2	8.3	13.5	15.1	12.4	15.1	6.7	6.6
P	41.6	48.5	58.0	51.9	59.9	57.3	40.8	47.7	46.2	44.3	58.0	56.1	39.7	45.8	43.9	42.8	53.1	50.8
	Conventional tillage technology – middle part of the slope																	
Date	15.6.2013		31.5.2014		1.6.2015		19.7.2013		4.7.2014		3.7.2015		3.8.2013		2.8.2014		1.8.2015	
Depth	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30
ρ_d	1.52	1.47	1.21	1.29	1.10	1.25	1.56	1.59	1.55	1.59	1.12	1.20	1.58	1.61	1.63	1.66	1.25	1.25
θ	30.5	31.9	18.4	19.6	10.9	18.2	15.0	15.0	18.8	21.4	8.9	8.9	14.8	16.7	10.7	11.9	5.4	5.4
P	41.9	43.9	53.8	50.7	58.0	52.3	40.5	39.3	39.3	40.8	39.3	57.3	54.2	39.7	38.5	37.8	36.6	52.3
	Conventional tillage technology – lower part of the slope																	
Date	15.6.2013		31.5.2014		1.6.2015		19.7.2013		4.7.2014		3.7.2015		3.8.2013		2.8.2014		30.7.2015	
Depth	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30
ρ_d	1.55	1.46	1.24	1.35	1.16	1.23	1.57	1.58	1.57	1.58	1.07	1.10	1.61	1.66	1.59	1.67	1.22	1.30
θ	31.9	33.3	17.6	18.6	10.2	12.7	15.5	17.9	18.4	19.6	8.3	8.5	16.8	19.0	11.2	14.0	5.7	5.6
P	40.8	44.3	52.7	49.5	55.7	53.1	40.1	39.7	40.1	39.7	59.2	58.0	38.6	36.6	39.3	26.3	53.4	50.4

Explanation: θ-actually soil moisture [% vol.], ρ_d-bulk density [$g.cm^{-3}$], P-porosity [% vol.]

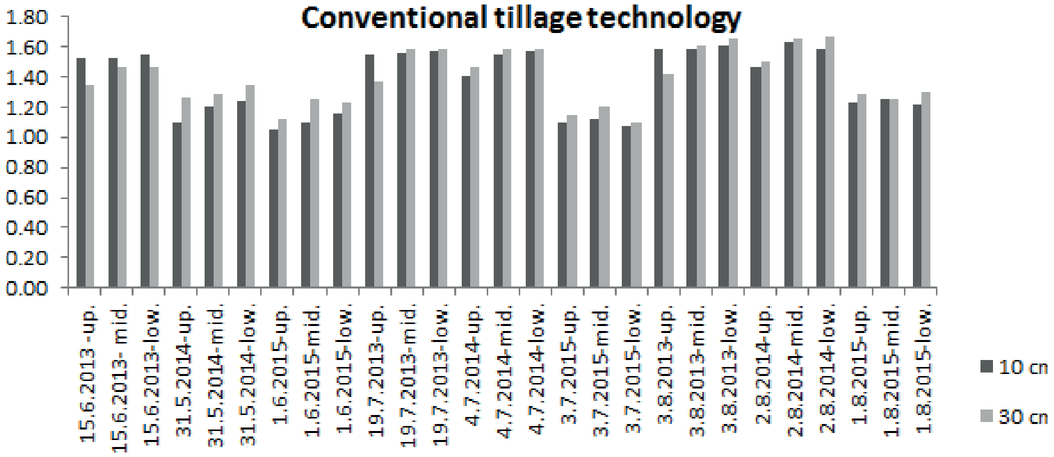
Reduced tillage technology – upper part of the slope																		
Date	15.6.2013		31.5.2014		1.6.2015		19.7.2013		4.7.2014		3.7.2015		3.8.2013		2.8.2014		1.8.2015	
Depth	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30
ρ_d	0.85	1.25	0.85	1.12	0.97	1.05	1.25	1.29	1.19	1.23	0.83	0.90	1.10	1.29	1.12	1.19	0.94	1.10
θ	35.5	39.3	20.6	23.1	10.7	12.4	14.8	17.3	22.7	25.7	8.9	8.9	32.5	35.5	12.4	15.1	6.7	6.6
P	67.6	52.3	67.5	57.3	63.0	59.9	52.7	50.7	54.5	53.1	68.3	65.6	58.0	50.7	57.3	54.6	62.9	50.4
Reduced tillage technology – middle part of the slope																		
Date	15.6.2013		31.5.2014		1.6.2015		19.7.2013		4.7.2014		3.7.2015		3.8.2013		2.8.2014		1.8.2015	
Depth	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30
ρ_d	0.90	1.27	0.97	1.23	1.04	1.15	1.21	1.21	1.20	1.23	0.90	0.95	1.25	1.29	1.15	1.27	1.01	1.09
θ	33.1	35.7	20.4	23.1	12.4	17.7	17.3	19.0	20.4	23.4	7.2	8.0	16.6	17.4	10.5	11.2	5.0	5.1
P	65.6	51.5	62.9	53.0	60.3	56.1	53.8	53.8	54.2	53.0	65.6	63.7	52.3	50.7	56.1	51.5	61.4	58.4
Reduced tillage technology – lower part of the slope																		
Date	15.6.2013		31.5.2014		1.6.2015		19.7.2013		4.7.2014		3.7.2015		3.8.2013		2.8.2014		1.8.2015	
Depth	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30	10	30
ρ_d	1.10	1.29	1.06	1.15	0.97	1.10	1.26	1.19	1.25	1.27	1.04	1.10	1.27	1.22	1.17	1.32	1.09	1.12
θ	32.5	35.0	17.6	18.6	10.2	12.7	16.6	17.4	20.8	24.9	7.2	7.1	19.3	21.5	9.1	12.6	5.3	5.6
P	58.0	50.7	59.5	56.1	62.9	58.0	61.9	54.6	52.3	51.5	60.3	58.0	51.5	53.4	55.3	49.6	58.4	58.4

Explanation: θ-actually soil moisture [% vol.], ρ_d-bulk density [$g.cm^{-3}$], P-porosity [% vol.]

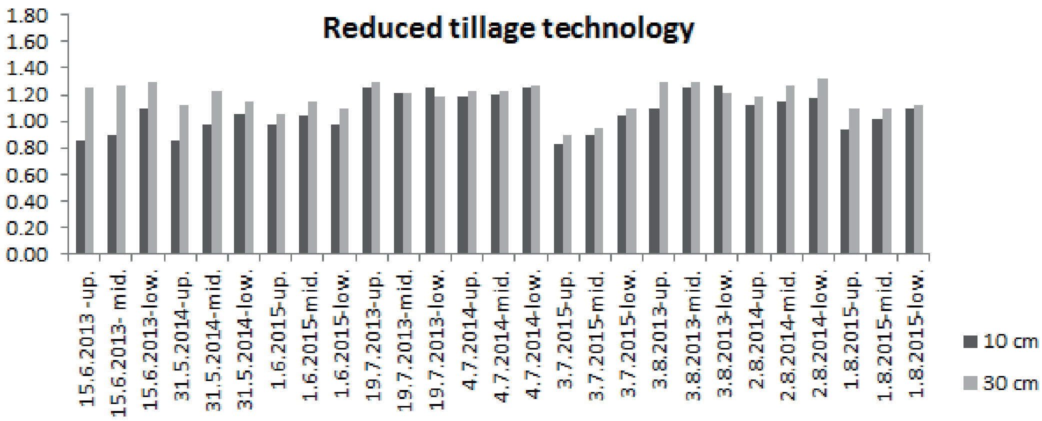
processed by the conventional tillage (ploughing) technology.

The value of porosity exceeds the critical value of % vol. 45 set by Lhotský (1984) also on the land processed by the conventional tillage (ploughing) technology.

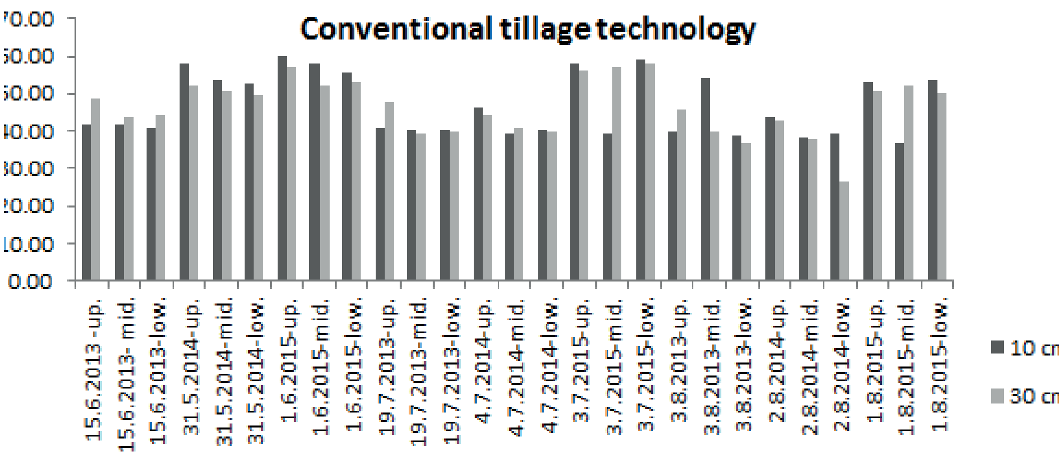
In Tables IIa and IIb, there are the tabular processed values of the cumulative infiltration *I(t)* in the times *t* for conventional tillage and reduced tillage processing in the years 2013–2015. Measuring of the cumulative infiltration is affected by the initial conditions of the experiment, which are the actually soil moisture and distribution in the soil pores. In Tables IIIa and IIIb, the re are the tabular processed values of the unsaturated hydraulic conductivity *K(h)*, tension value was -2 cm, *h(-2)*.



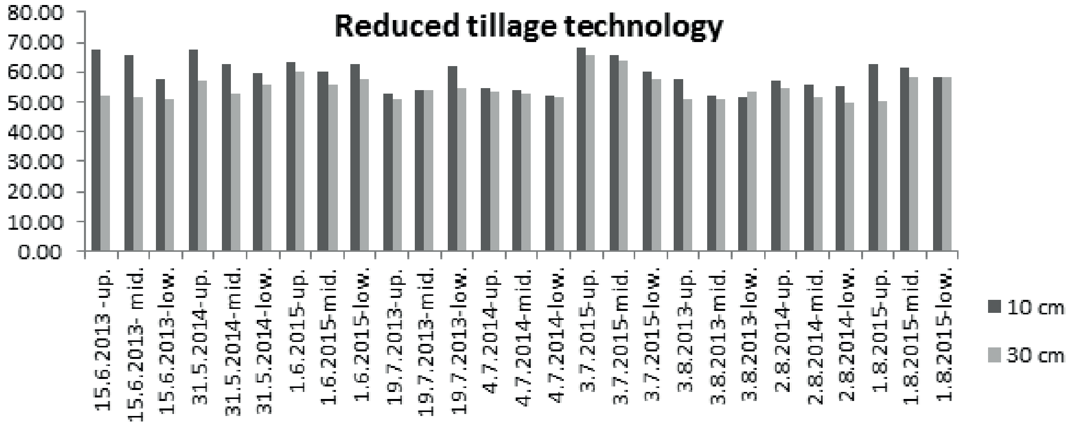
3: *Bulk density – conventional tillage technology*



4: *Bulk density – reduced tillage technology*



5: *Porosity – conventional tillage technology*

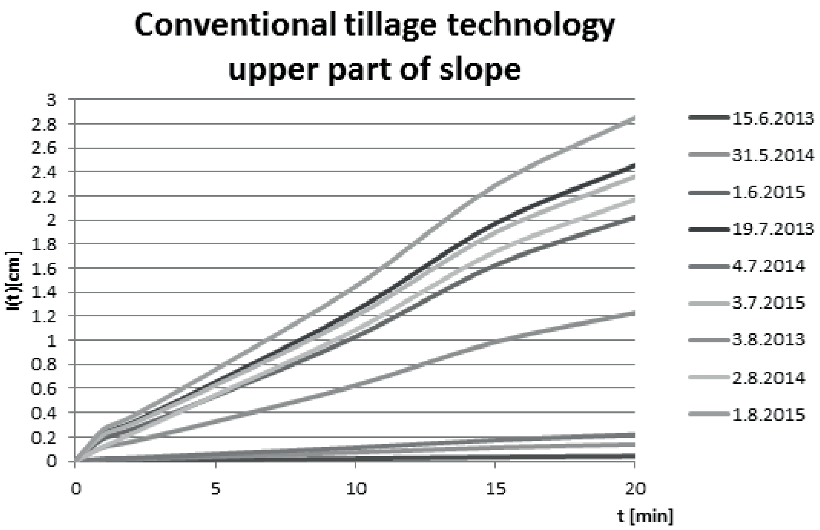


6: *Porosity – reduced tillage technology*

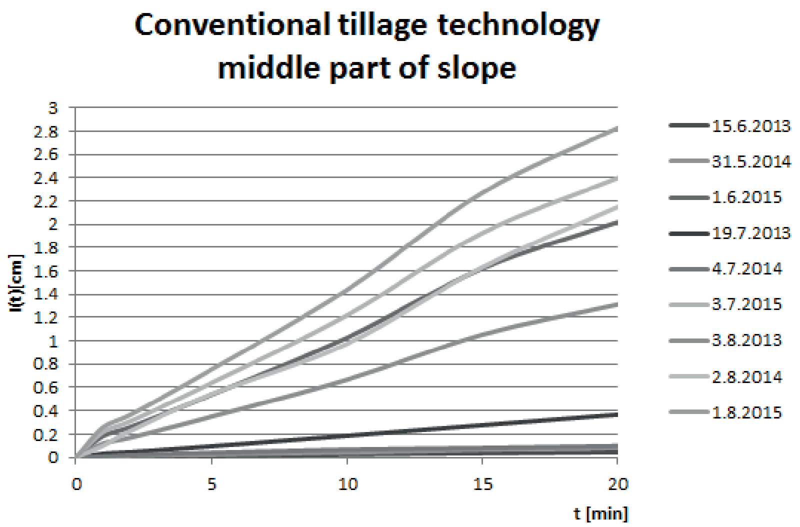
II: *a,b – The value of the cumulative infiltration I(t) for the conventional tillage and reduced tillage technology in the years 2013-2015*

Conventional tillage technology – upper part of the slope									
Date	15.6.2013	31.5.2014	1.6.2015	19.7.2013	4.7.2014	3.7.2015	3.8.2013	2.8.2014	1.8.2015
t[min]					I(t) [cm]				
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0038	0.0132	0.1869	0.2267	0.0205	0.2180	0.1152	0.1197	0.2629
2	0.0053	0.0182	0.2618	0.3175	0.0248	0.3054	0.1602	0.2249	0.3684
5	0.0107	0.0370	0.5402	0.6551	0.0571	0.6300	0.3288	0.5473	0.7599
10	0.0204	0.0704	1.0303	1.2494	0.1105	1.2017	0.6262	1.0888	1.4495
15	0.0321	0.1110	1.6263	1.9722	0.1743	1.8969	0.9880	1.7383	2.2880
20	0.0400	0.1381	2.0253	2.4559	0.2167	2.3622	1.2302	2.1718	2.8491
Conventional tillage technology – middle part of the slope									
Date	15.6.2013	31.5.2014	1.6.2015	19.7.2013	4.7.2014	3.7.2015	3.8.2013	2.8.2014	1.8.2015
t[min]					I(t) [cm]				
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0046	0.0079	0.1864	0.0353	0.0109	0.2214	0.1223	0.1035	0.2610
2	0.0063	0.0109	0.2611	0.0485	0.0217	0.3101	0.1705	0.2278	0.3657
5	0.0128	0.0229	0.5388	0.0986	0.0423	0.6398	0.3506	0.5437	0.7545
10	0.0244	0.0435	1.0277	0.1874	0.0697	1.2203	0.6681	0.9753	1.4391
15	0.0361	0.0685	1.6222	0.2774	0.0843	1.9262	1.0543	1.6338	2.2716
20	0.0479	0.0853	2.0201	0.3677	0.1009	2.3987	1.3128	2.1500	2.8288
Conventional tillage technology – lower part of the slope									
Date	15.6.2013	31.5.2014	1.6.2015	19.7.2013	4.7.2014	3.7.2015	3.8.2013	2.8.2014	1.8.2015
t[min]					I(t) [cm]				
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0096	0.0058	0.1697	0.0119	0.0092	0.2283	0.0145	0.1936	0.2340
2	0.0132	0.0080	0.2377	0.0163	0.0127	0.3199	0.0200	0.2708	0.3278
5	0.0269	0.0162	0.4905	0.0332	0.0254	0.6601	0.0406	0.5579	0.6764
10	0.0511	0.0308	0.9355	0.0631	0.0507	1.2589	0.0772	1.0638	1.2901
15	0.0805	0.0486	1.4767	0.0935	0.0800	1.9873	0.1142	1.6791	2.0365
20	0.1002	0.0605	1.8389	0.1240	0.1000	2.4747	0.1515	2.0908	2.5360

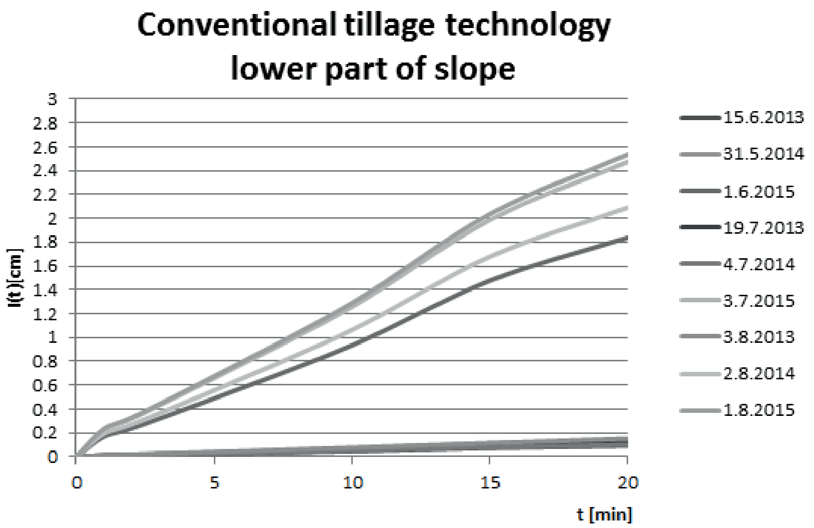
Conventional tillage technology – upper part of the slope									
Reduced tillage technology – upper part of the slope									
Date	15.6.2013	31.5.2014	1.6.2015	19.7.2013	4.7.2014	3.7.2015	3.8.2013	2.8.2014	1.8.2015
t[min]	I(t) [cm]								
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0088	0.0132	0.1936	0.1223	0.1004	0.2742	0.2742	0.1169	0.4964
2	0.0121	0.0182	0.2708	0.1705	0.2156	0.3859	0.3859	0.1627	0.7100
5	0.0249	0.0370	0.5579	0.3506	0.4064	0.7990	0.7990	0.3340	1.4864
10	0.0474	0.0704	1.0638	0.6681	0.9634	1.5254	1.5254	0.6361	2.8463
15	0.0747	0.1110	1.6791	1.0543	1.1926	2.4085	2.4085	0.8809	4.4980
20	0.0930	0.1381	2.0908	1.3128	1.2678	2.9994	2.7038	1.2497	5.6031
Reduced tillage technology – middle part of the slope									
Date	15.6.2013	31.5.2014	1.6.2015	19.7.2013	4.7.2014	3.7.2015	3.8.2013	2.8.2014	1.8.2015
t[min]	I(t) [cm]								
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0156	0.0079	0.1864	0.1197	0.0353	0.2283	0.1752	0.1161	0.4581
2	0.0215	0.0109	0.2611	0.1697	0.0485	0.3199	0.2956	0.1674	0.6980
5	0.0440	0.0229	0.5388	0.3456	0.0986	0.6601	0.8430	0.4331	1.3273
10	0.0838	0.0435	1.0277	0.6521	0.1874	1.2589	1.4678	0.6351	2.6432
15	0.1321	0.0685	1.6222	1.2009	0.2774	1.9873	2.3509	0.9345	4.2167
20	0.1645	0.0853	2.0201	1.2341	0.3677	2.4747	2.6640	1.2389	5.0871
Reduced tillage technology – lower part of the slope									
Date	15.6.2013	31.5.2014	1.6.2015	19.7.2013	4.7.2014	3.7.2015	3.8.2013	2.8.2014	1.8.2015
t[min]	I(t) [cm]								
0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
1	0.0205	0.0058	0.1697	0.1169	0.0145	0.2103	0.1632	0.1152	0.3669
2	0.0284	0.0080	0.2377	0.1627	0.0200	0.2945	0.2697	0.1602	0.5188
5	0.0581	0.0162	0.4905	0.3340	0.0406	0.5623	0.7342	0.3288	1.0776
10	0.1105	0.0308	0.9355	0.6361	0.0772	1.2500	1.2674	0.6262	2.0590
15	0.1742	0.0486	1.4767	1.0037	0.1142	1.8419	2.1067	0.9880	3.2518
20	0.2169	0.0605	1.8389	1.2497	0.1515	2.3164	2.0058	1.2302	4.0499



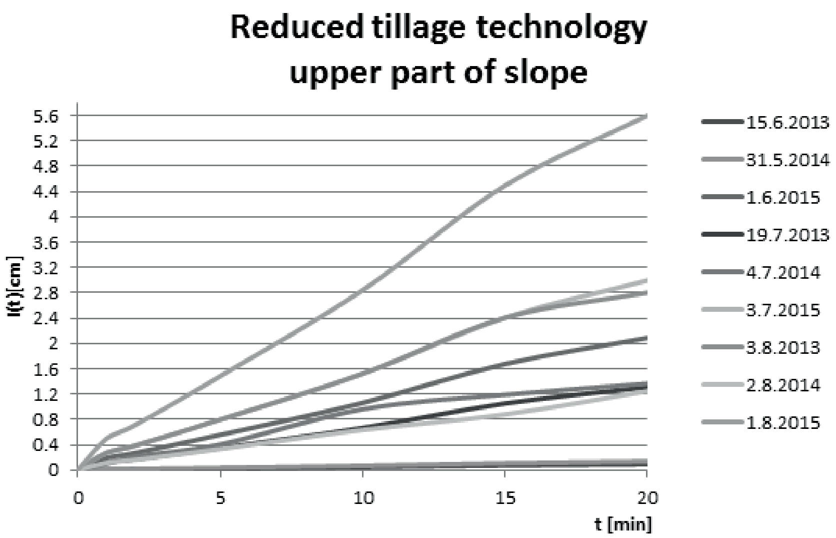
7: *Cumulative infiltration I(t) for plot with conventional tillage technology*



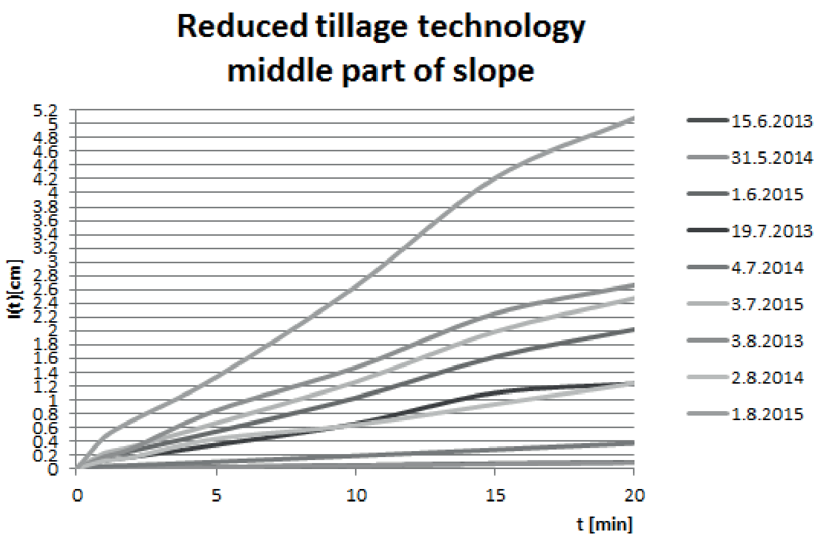
8: *Cumulative infiltration I(t) for plot with conventional tillage technology*



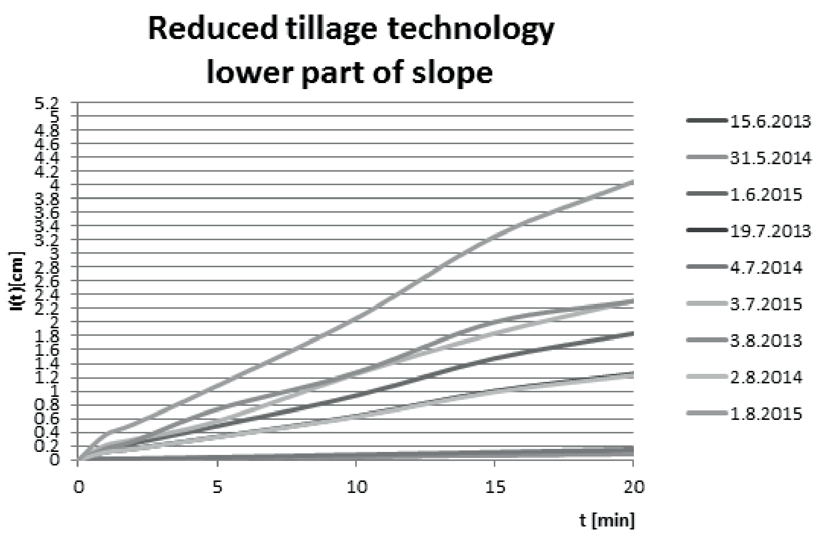
9: *Cumulative infiltration I(t) for plot with conventional tillage technology*



10: *Cumulative infiltration I(t) for plot with reduced tillage technology*



11: *Cumulative infiltration I(t) for plot with reduced tillage technology*



12: *Cumulative infiltration I(t) for plot with reduced tillage technology*

CONCLUSION

From the results, it is evident that the land processed by the reduce tillage technology does not exceed the critical values, as the bulk density, thus porosity. The values set on the land processed by the conventional tillage technology point to a higher level of soil compaction and the disorder of the soil structure. Adverse destruction of the structure when ploughing is highlighted by the process of soil compaction, which can cause compacting of the subsoil and soil crust is formed on the soil surface, which stops water infiltration into the soil, especially in short-term torrential rains.

The physical properties of the soil horizon with conventional tillage technology has got worse, on the surface, with reduced tillage technology, has improved. The physical properties of the upper soil layer was more stable on the surface with reduced tillage, which had an effect on the growth, development and yield of crops, but also in monitoring the infiltration of water into the soil layer. The soil profile processed by conventional tillage technology showed a higher degree of compaction, the bulk density was between 1.10–1.67 g.cm^{-3}, compared to the land processed by the reduced tillage technology, where the values were between 0.80-1.29 g.cm^{-3}. Unsaturated hydraulic conductivity values were about one-third higher within reduced tillage soil technology.

III: *a,b – Unsaturated hydraulic conductivity K(h) in the years 2013–2015*

Conventional tillage technology			
	K(-2) [cm.min^{-1}]		
Date	**upper part**	**middle part**	**lower part**
15.6.2013	$1{,}41.10^{-5}$	$3{,}12.10^{-5}$	$1{,}24.10^{-4}$
31.5.2014	$1{,}38.10^{-4}$	$1{,}27.\ 10^{-4}$	$2{,}98.\ 10^{-5}$
1.6.2015	$1{,}18.10^{-3}$	$1{,}02.\ 10^{-4}$	$1{,}13.\ 10^{-4}$
19.7.2013	$1{,}59.10^{-3}$	$5{,}78.10^{-4}$	$1{,}09.10^{-4}$
4.7.2014	$3{,}74.10^{-4}$	$1{,}20.\ 10^{-4}$	$1{,}20.\ 10^{-4}$
3.7.2015	$1{,}25.10^{-3}$	$1{,}26.10^{-3}$	$1{,}26.10^{-3}$
3.8.2013	$1{,}59.10^{-3}$	$1{,}5.10^{-3}$	$3{,}44.10\text{-}^{4}$
2.8.2014	$1{,}40.\ 10^{-5}$	$1{,}41.\ 10^{-5}$	$1{,}30.\ 10^{-4}$
1.8.2015	$2{,}93.\ 10^{-5}$	$2{,}85.10^{-3}$	$2{,}84.10^{-3}$

Reduced tillage technology			
	K(-2) [cm.min^{-1}]		
Date	**upper part**	**middle part**	**lower part**
15.6.2013	$3{,}59.10^{-4}$	$7{,}81.10^{-5}$	$1.00.10^{-4}$
31.5.2014	$1{,}38.10^{-4}$	$1{,}27.\ 10^{-4}$	$2{,}98.\ 10^{-5}$
1.6.2015	$1{,}79.10^{-3}$	$1{,}14.\ 10^{-4}$	$1{,}03.\ 10^{-4}$
19.7.2013	$3{,}12.10\text{-}^{4}$	$3.55.\ 10\text{-}^{4}$	$4.01.10\text{-}^{4}$
4.7.2014	$1.78.\ 10^{-3}$	$0.98.10^{-3}$	$8.47.10^{-4}$
3.7.2015	$2{,}29.10^{-3}$	$2{,}06.10^{-3}$	$1{,}47.10^{-3}$
3.8.2013	$3.73.10^{-4}$	$3.83.10^{-4}$	$2.13.10^{-4}$
2.8.2014	$1.33.\ 10^{-3}$	$1.77.\ 10^{-3}$	$1{,}59.10^{-3}$
1.8.2015	$3{,}09.10^{-3}$	$3.47.10^{-3}$	$3{,}52.10^{-3}$

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