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Soil hydrophysical and Microbiological Characteristics Changes Originate in Repeated Identical Top-soil Treatment

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Arable land forms an important cover of Earth surface in Europe and other parts of World. A tillage treatment is well known and applied treatment of the top soil profile layer. The physical conditions of the top layer determine water infiltration into a soil profile, runoff losses and biological characteristics of the soil profile. This study is focused on the influence of repeated tillage treatments (included no-till) in the same locality on saturated hydraulic conductivity and on biological characteristics in a relatively homogeneous soil profile. The experimental soil profile was classified as Hapludalfs (US Classification) / Orthic luvisol (FAO). The field experimental work was conducted in 1997, repeated in 2000 after three years of repeated treatments and again after six years (in 2003) of the same repeated treatments. In 1994 the whole experimental site was divided into four tillage treatment areas (TTA) that where maintained using repeatedly different tillage treatments in each TTA (Matula, 2003). Three types of tillage treatments were applied repeatedly - conventional (CT), reduced till (RT) and no-till (NT) at the same TTA.

From the hydro-physical point of view the tillage treatment plays the key role in changes of the saturated hydraulic conductivity (K) of the treated layer. A pressure ring infiltrometer (Matula and Kozáková, 1997) was used to run infiltration tests. The infiltration during the steady state flow was measured, evaluated and$K$ values were calculated. Matula (2002) summarized the theoretical background for the pressure ring infiltrometer (Reynolds and Elrick, 1990) and described the final equations for evaluation of the infiltration test results for particular infiltometer.

The conventional tillage did not give any significant changes in K values after three and six years except fluctuation of values K. Some differences that can be seen seem to be related to very large heterogeneity of the top layer after conventional tillage. Repeated application of the reduced till treatment did show a small fluctuation in$K$ and tendency is stable. No-till treatment shows again a significant decrease in the infiltration rate v (t) after three years. After three years the K value in this case decreased approximately three times for reduced till and six times for no-till treatment. After six years the K values of the reduced till treatment shows not significant changes, K in locations two and five are slightly higher, almost back to the situation in 1997, the rest of locations show decrease again. No-till treatment shows a significant decrease in K values again, approximately eight times compare to the situation in 2000. The increased pore continuity, mentioned by Beaumer (1992) did not increase in this particularly soil under reduced till (TTA4/TTA01) and no-till (TTA3/TTA03). An influence of increased soil worm's population in reduced till treatment and no-till treatment areas creating the worm holes (Hillel, 1998) affecting positively the flow of water was also not registered at all.

Decrease in K of the top layer on this type of soil may cause several negative results from the aspect of surface soil hydrology and agriculture; surface runoff increase, soil water storage decrease, yield decrease, increase in soil compaction of surface layer, and soil erodibility (Hillel, 1998) increase.

The biological characteristics under conventional tillage, reduced till and no-till treatments were studied in 2000 and 2003. The distribution of biological activities in the layers 0 – 0.1m, 0.1-0.2m and 0.2-0.3m was compared for all three treatments.

Generally, a moderate increase of organic carbon content (C_{org}), microbial biomass and dehydrogenase activity was observed in all treatments in the year 2003 compared to 2000. Particularly, the accumulation of the organic carbon in the surface layer was found under reduced till and no-till. The contents of organic carbon were more balanced throughout the layers under conventional tillage than under reduced till or no-till. Last two treatments showed larger organic carbon content in the surface layer where following values in 2003 (after nine years of different tillage practices) were found in layers 0.0 – 0.1 m, 0.1 - 0.2 m and 0.2 - 0.3 m:

CT = 1.39%, 1.33% and 1.28% C_{org}; RT = 1.63%, 1.41% and 1.24% C_{org}; NT = 1.62%, 1.39% and 1.24% C_{org}.

Even greater differences than found for C_{org} were found for soil microbial biomass and dehydrogenase activity between the surface layer and the depths 0.1 - 0.2 m and 0.2 - 0.3 m under RT and NT. The microbial biomass and dehydrogenase activities were more balanced under CT throughout the studied soil horizon.

The data obtained showed the greater increase of soil organic matter under RT and no-till practices than under conventional tillage and the accumulation of the organic matter and microbial activities in the surface layer of soil horizon after nine years of the experiment under reduced till and no-till.

Key words: saturated hydraulic conductivity (K), conventional tillage, reduced till, no-till, pressure infiltrometer, infiltration test, transect, organic carbon content, microbial biomass, dehydrogenase activity