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Soil Tillage Conservation and its Effect on Soil Organic Matter, Water Management and Carbon Sequestration

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Organic matter is an extremely important constituent of soils and is vital to many of the hydrological, biological and chemical reactions required for sustaining plant life. We present the influence of conventional plough tillage system on soil, water and organic matter conservation in comparison with an alternative minimum tillage system (paraplow, chisel plow and rotary harrow). The influence of tillage soil system upon water supply accumulated in soil was studied on several soil types at the University of Agricultural Sciences and Veterinary Medicine of Cluj Napoca. The application of minimum tillage systems increased the organic matter content 0.8 to 22.1% and water stabile aggregate content from 1.3 to 13.6%, in the 0-30 cm depth, as compared to the classical system. For the organic matter content and the wet aggregate stability, the statistical analysis of the data showed, increasing positive significance of minimum systems. Statistical analysis regarding the organic matter content of the studied systems shows significant positive values on Haplic luvisols under paraplow and chisel tillage as well on Typic Phaeozems under paraplow and rotary harrow tillage. Multiple comparisons between systems indicate advantages for using the paraplow on Phaeozems, chisel on Haplic luvisols and rotary harrow on Molic Fluvisol. Multiple analysis of soil classification and tillage system on the hydric stability of soil structure have shown that all variants with minimum tillage are superior, having a positive influence on soil structure stability. While the soil fertility and the wet aggregate stability were initially low, the effect of conservation practices on the soil features resulted in a positive impact on the water permeability of the soil. Availability of soil moisture during the crop growth resulted in better plant water status. Subsequent release of conserved soil water regulated proper plant water status, soil structure, and lowered soil penetrometer resistance.
Carbon sequestration in soil has clear advantages, such as improving the productivity and sustainability. The higher the organic content in soil is the better the soil aggregation is. The soil without organic content is compact. This reduces its capacity to infiltrate water, nutrients solubility and productivity, and implicit it reduces the soil capacity for carbon sequestration. Furthermore, it increases soil vulnerability to erosion through water and wind. Soil carbon dioxide concentration dynamics can be presently continuously monitored using the latest available sensors. Systems for soil gas measurements offer crucial information regarding production, consumption, and gas transportation, with major implications in quantitative and qualitative assessment of soil respiration and soil aeration.
Continuous measurement of CO_2 concentrations and gas flow calculations on the surface, by estimating the diffusion coefficient of soil, reveals reduplication of the amount issued in the case of the classic version plough. An exceeding amount of CO_2 produced in the soil and released into the atmosphere, resulting from aerobic processes of mineralization of organic matter (excessive loosening) is considered to be not only a way of increasing the CO_2 in the atmosphere, but also a loss of long-term soil fertility. This indicates an acceleration of the mineralization process of soil organic matter and of the pedogenetical process of soil degradation. Minimum tillage systems significantly alter the amount of CO_2 released into the atmosphere, reducing to less than half its diffusion. Thus, based on the results achieved, it was estimated an amount of 6.9 million tons / year of carbon stored in arable soils of Romania, if the minimum tillage system would be implemented on 50% of the arable land, with influence on the soil fertility conservation and climate change.