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Long-term effects of conventional and reduced tillage systems on soil condition and yield of maize

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As a consequence of operations which neglect soil condition and consist of frequent soil disturbance, conventional tillage (primary tillage with autumn ploughing) results in the degradation and compaction of soil structure, as well as the reduction of organic matter. These unfavourable processes pose an increasing economic and environmental protection problem today. The unfavourable physical condition of soils on which conventional tillage was performed indicate the need for preserving methods and tools.
The examinations were performed in the multifactorial long-term tillage experiment established at the Látókép experiment site of DE MÉK. The experiment site is located in the Hajdúság loess ridge (Hungary) and its soil is loess-based calcareous chernozem with deep humus layer. The physical soil type is mid-heavy adobe. The long-term experiment has a split-split plot design. The main plots are different tillage methods (autumn ploughing, spring shallow tillage) without replication. In this paper, the effect of conventional and reduced (shallow) tillage methods on soil conditions and maize yield was examined. A manual penetrometer was used to determine the physical condition and compactedness of the soil. The soil moisture content was determined with deep probe measurement (based on capacitive method). In addition to soil analyses, the yield per hectare of different plots was also observed.
In reduced tillage, one compacted layer is shown in the soil resistance profile determined with a penetrometer, while there are two compacted layers in autumn ploughing. The highest resistance was measured in the case of primary tillage performed at the same depth for several years in the compacted (pan disk) layer developed under the developed layer in both treatments. The unfavourable impact of spring shallow primary tillage on physical soil conditions is shown by the fact that the compaction of the pan disk exceed the critical limit value of 3 MPa. Over the years, further deterioration of physical conditions were observed below the regularly cultivated layer.
In shallow tillage, soil contained more moisture (at 40-50 cm deep and below) than in the ploughed treatment. There are multiple reasons for this phenomenon. This tillage method is moisture preserving as the depth of disturbance (15 cm) is lower than in ploughed treatments (25-30 cm). Soil surface is covered by stem residues after sowing, which may reduce the extent of evaporation.
The soil surface CO_2 emission was determined based on primary tillage depth, intensity and the period which passed since primary tillage. Spring shallow primary tillage resulted in higher CO_2 emission than conventional tillage.
The average maize yield was significantly higher in the autumn ploughing treatment (6,6-13,9 t/ha) in the first half (7 years) of the examined period (2000-2014). Higher average yields were observed in two years in the spring shallow tillage treatment and no significant yield difference was observed between tillage treatments in other examined years.
Reduced (shallow) tillage increases the risk of near-surface soil compaction and the biological activity of the soil, while it reduces the moisture loss of the soil. Reducing tillage intensity does not necessarily reduce the average yield of the produced crop (maize).