CORRELATION BETWEEN MOISTURE AND ORGANIC MATTER CONSERVATION IN SOIL TILLAGE

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Introduction

The aims of tillage are to improve and maintain the soil physical and biological conditions, corresponding to production and conservation requirements. Both land use and tillage, through the soil condition, affects the water and organic material management in soils (Table 1), by this means climatic extremities (drought, abundant rain) affects.

Table 1. Land use and tillage impacts on soil damages

Land use-induced harms	Soil		Tillage-induced harms
	layer	condition	
• Organic matter loss • Soil, nutrient and water loss • Soil biological mellowing cut • Destroying the living site of earthworms • Beneficial organisms activity declining • Beneficial biochemical processes stagnation • Anaerobiosis – pathogenic organisms activity stimulation • Promoting unfavourable chemical processes • Deterioration in soil culture condition • Increasing soil sensitivity and vulnerability	toplayer tilled layer	degraded structure	• Carbon loss • Extreme water loss – soil drying • Bare surface – greater vulnerability • Clod and dust formation cycles • Water and wind erosion occurrence and extension • Compaction and recompaction • Water-logging on compacted surface and/or tillage pans • Deterioration in soil workability and trafficability
	root zone	compaction and recompaction	
	subsoil	natural and/or human-induced compaction	

In conventional tillage practice there are some unesseririly practices, such as summer ploughing or deep stubble stripping without surface preparing, which may cause strong water and carbon loss during the season (ECAF, 1999; Nyakatagawa, et. al, 2001). These symptoms may call attention to reform tillage operations, including deep or rough disturbance of soil, primarily under extreme climatic conditions. That's why, the purpose of the tillage in droughty years to increase the water retention and to mitigate moisture and carbon loss from soil. However, the requirement in rainy years is to improve and to maintain the water infiltration rate. Researchers have devoted a great deal of attention to the tillage-induced water loss during the last decades (Gyuricza, 2000). However, the interest in soil organic matter, including its response to tillage or management practices is

DOI: 10.1556/CRC.33.2005.1.5

relatively new. A next step may be to assess the possible correlation between moisture and organic matter management in soil tillage.

Methods

This study is based on data of monitoring and the long-term experiments. The monitoring started in 1976 following the periods of the tillage practice, and covered 31,000 ha in 41 districts (including Hatvan) of Hungary. Tillage impacts on soil quality were examined in Gödöllő, on a sandy loam, brown forest soil (Chromic Luvisol) from 1991 to 2002 (5 variants) and in Hatvan on a loam (Calcic Chernozem) from 2002 (6 variants). Soil state variants are grouped in 4, namely settled, loosened shallowly, ploughed and loosened. In the first place three fertilization levels and biculture (maize-wheat sequence) was used and in the second trial an optimal fertilization level was applied, and the crop sequence – wheat-maize – was improved by catch crops (mustard, rye, pea). During the period from 1991 to 2004, 6 years were average (1991, 1993, 1995, 1996, 2002, 2004), 6 were dry (1992, 1994, 1997, 2000, 2003) and 3 were rainy (1998, 1999, 2001). The tillage effects, including water and humus content, CO_2 emission and agronomical texture (aggregate and dust rate) were determined according to the accepted standards (cit. Birkás, 2000; Gyuricza, 2000). Some results were published both in Hungarian and international relation (Birkás and Gyuricza, 2004; Birkás et al., 2004). Our primary objectives was to evaluate the long-term tillage effect on soil moisture and organic matter content with a simplified method. The secondary objective was to summarize the factors affecting water and organic matter conservation in any tillage system.

Results and discussion

Soil moisture content rate affected by different soil disturbance is shown in Figure 1, where the basis of relation is the ploughing variant.

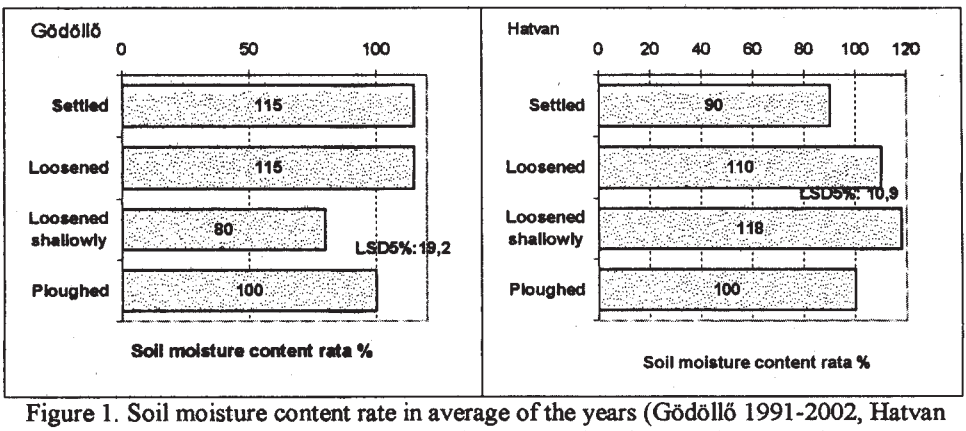

Figure 1. Soil moisture content rate in average of the years (Gödöllő 1991-2002, Hatvan 2002-2004); (Soil disturbance in Loosened variant reaches 45 cm)

The natural water management properties of the soil can not be improved however the water infiltration and the loss may be controlled by tillage methods (Várallyay, 1996). In a long- and short term relation, both deeper and slight disturbance resulted higher

moisture content presumably reflecting the better intake and conservation. The water storage was average in the ploughed soils.
Tillage may characterize to loss of humus through the soil disturbance (Figure 2). In a long-term relation the organic matter conservation occurred in the slightly disturbed soils. The ploughed variant showed a slightly conservation although the stubble residues were incorporated to the soil for years.

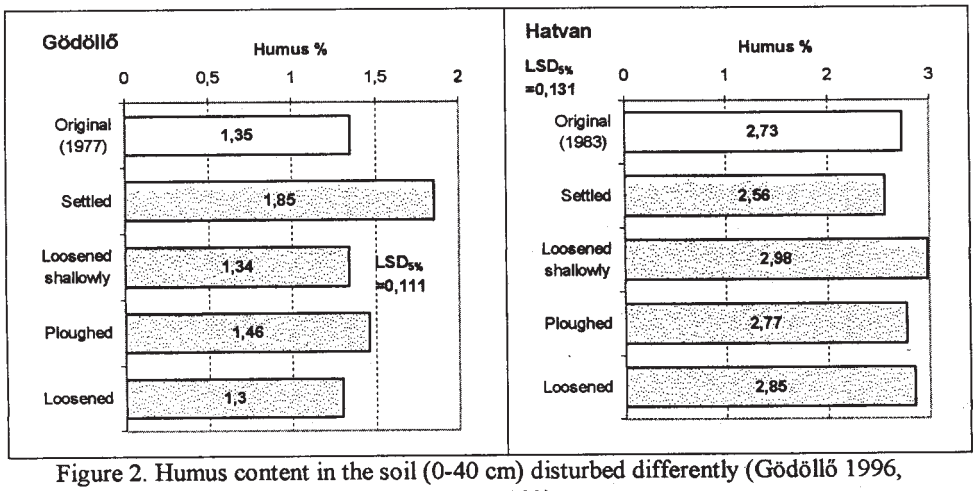

Figure 2. Humus content in the soil (0-40 cm) disturbed differently (Gödöllő 1996, Hatvan, 2003)

These results reconfirmed that less soil disturbance can be applied to conserve organic matters effectively, however to disturb a soil frequently promotes the loss of humus in a long-term. Considering the water and organic matter loss and conservation there are similarities among the soil condition variants (Table 2).

Table 2 Rank of soil condition considering water and organic matter content

Place (years)	Factor	Rank of soil condition
Gödöllő (10)	Water content	Loosened = **Settled** > Ploughed > Loosened shallowly
	OM content	**Settled** > Ploughed > Loosened shallowly > Loosened
Hatvan (3)	Water content	**Loosened shallowly** > Loosened > Ploughed > Settled
	OM content	**Loosened shallowly** > Loosened > Ploughed > Settled

Both water and organic matter management is dependent upon factors that affect their input and output. Organic matter input may depend on stubble residues incorporation, however the output affects by decomposition through some factors, including soil disturbance. Soils due to tillage and cropping methods have contributed to CO_2 emission to the atmosphere (Figure 3).

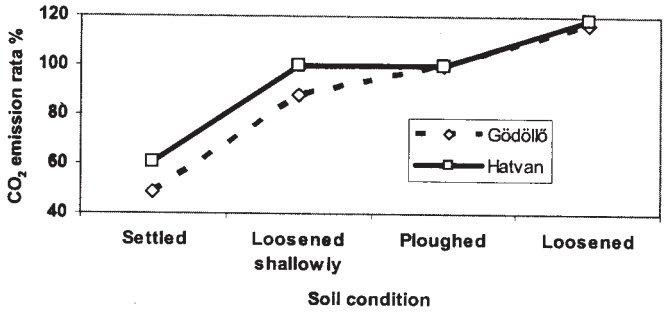

Figure 3. CO_2 emission tendency at different soil condition (Gödöllő 2002, Hatvan 2004) (Emission of ploughed soil = 100 %)

It seems that the water conservation tillage may mitigate CO_2 emission and it may promote harmony between carbon storage and decomposition. When carbon loss may occur, primarily on deeply disturbed soil, use of surface preparation and mulching helps to restore soil carbon. A good challanges, that a well-adopted tillage system may mitigate the organic matter loss of soils.

Conclusions

Tillage may influence water and organic matter dynamics through various mechanisms. There are factors to mitigate both water and organic matter loss: (1) Use water, organic matter and soil structure conservation tillage, (2) Form the surface of deeply tilled soils, (3) Mulch and recycle stubble residues, (4) Use crops with high biomass, (5) Use cover crops (Hungarian green land program), (6) Promote soil mellowing, (6) Reduce physical and chemical load of soils, (7) Prevent and alleviate soil harms (compaction and pulverization).

Acknowledgements

This paper presents results of research programs supported by NKFP-OM-3B/0057/2002, OTKA-34.274, OTKA- 46.670

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