SOIL FERTILITY CHARACTERITICS DUE TO DIFFERENT ORGANIC AND MINERAL FERTILIZATION

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Introduction

Total organic matter content of soil is the most commonly used indicator for soil quality. However, this is a rather heterogeneous substance and his impact on soil fertility is hardly definable exactly. From the point of view of soil fertility, soil organic matter (SOM) can be separated into two parts: one is resistant to mineralization processes correlating highly with clay content of soil and is considered to be site specific; another part is decomposable, supplies plant nutrients and its amount is management specific (Schulz, 2004). The decomposable part of SOM can be determined by hot water soluble carbon content of a soil (HWC), which probably represents the annually decomposing and mineralising part of organic matter (Weigel et al., 1997). Results of Ghani et al. (2003) referred, that HWC was one of the most sensitive indicators among the biochemical measurements on a sandy loam, reflecting the changes in SOM caused by different management practices. The living soil microbial biomass (MBC) is an important fraction of SOM as well, representing a considerable part of HWC.

The aim of this study was to compare the long-term effects of FYM, straw incorporation and mineral fertilization on some parameters of SOM and soil fertility using selected treatments of a long-term field experiment.

Materials and methods

The long-term experiment was set up on a Eutric Cambisol at Keszthely /Hungary (46°47' N; 17°15' E) in 1963, with two crop rotations of sugar beet or potato as initial crops plus winter wheat - winter wheat – maize - maize. The mean annual temperature and precipitation are 10.4 °C and 654 mm, respectively. Soil texture is loam; humus: 1.5%; clay: 21.3%; pH_{H2O}: 7.3. For more information see Hoffmann et al. (2002). Three variations of FYM, three of equivalent doses of NPK fertilizer and four of straw manuring as well as an unfertilized control plot have been selected for our investigations (Table 1). In case of HWC and MBC the analyses did not contain treatment 10. Composite soil samples were taken from the 0-20 cm soil layer, 10 samples from each plot, several times, in 1983 and 2002 for TOC analyses and in 2004 and 2005 for HWC and MBC analyses. The results of HWC and MBC are mean of three different soil sampling dates. SOM was analysed according to Turin's method (Búzás, 1988) and TOC was calculated by division of 1.724. HWC was determined after 1-hour boiling in distilled water (Schulz, 1997, Schulz et al. 2002). MBC was carried out by the fumigation-extraction method (Vance et al., 1987). Data were analysed by Duncan-test for determining significant differences using SPSS 9.0 software.

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Table 1. The short description of the selected fertilization treatments.

	Treatments	*Abbreviations*	*N-fertil. kg* $ha^{-1}a^{-1}$
1	Control	Cont	0
2	35 t ha^{-1} yr^{-1} FYM for 5 years (in 2 doses)	1 FYM	43,5
3	70 t ha^{-1} yr^{-1} FYM for 5 years (in 2 doses)	2 FYM	87,0
4	105 t ha^{-1} yr^{-1} FYM for 5 years (in 2 doses)	3 FYM	130,5
5	35 t ha^{-1} yr^{-1} FYM equivalent mineral NPK	1 eqv	43,5
6	70 t ha^{-1} yr^{-1} FYM equivalent mineral NPK	2 eqv	87,0
7	105 t ha^{-1} yr^{-1} FYM equivalent mineral NPK	3 eqv	130,5
8	mineral NPK	NPK	171,5
9	mineral NPK + maize stalk	NPK+ms	171,5
10	mineral NPK + wheat straw	NPK+ms+ws	171,5
11	mineral NPK + maize stalk + wheat straw	NPK+ms+ws	171,5

Results and discussion

TOC content: Figure 1 contains TOC contents of soils 20 and 40 years after initiation of the field experiment. Without any fertilization TOC content of soil decreased, but the change was not proved statistically. Low mineral fertilization (1 eqv) caused a slight reduction of TOC as compared to initial value (0.87%) or to the control treatment. FYM of 35t ha^{-1} (7t$ha^{-1}$$yr$-^{1}) seemed to be almost sufficient for keeping the initial organic matter content of the soil. These data are similar to the results of Körschens (2002), suggesting that an annual FYM application of 10t ha^{-1} is required to maintain soil organic matter content. Higher FYM doses (14 - 21 t ha^{-1}) had definite positive effect on TOC content, while equivalent NPK fertilization effect was slighter. Increasing sole NPK fertilizer-rates (1, 2, or 3 eqv) increased TOC content of soil as well. Incorporation of maize stalk and wheat straw had additional positive influence and resulted in the highest soil TOC reserves.

HWC content:. The quantity of HWC was different depending on type of fertilization (Figure 2). On the average long-term FYM treatments performed about 18% more HWC than mineral fertilization. FYM application provides a high C input which is more or less available depending on its quality. Application of mineral fertilizers cause only indirectly a C input via increase in harvesting and root residues as decomposable C sources; contribution to hot water extractable C pool is lower compared to FYM application. Calculated on the same NPK level ploughing down of maize stalk and wheat straw resulted in similar rates of HWC as it could be seen in case of FYM manuring.

MBC content. In contradiction to the results that were obtained in case of HWC, FYM treatments resulted in lower amounts of soil microbial biomass (MBC) than sole mineral fertilization or combined with straw incorporation (Figure 3). The higher values of MBC are probably due to the greater amount of accompanying plant residues of mineral fertilization, ensuring more substratum for microbial communities and more available nitrogen for microbial growth. However too much fertilizer (3eqv, NPK) seemed to be unbeneficial to soil micro-organism.