VERTICAL DISTRIBUTION OF SOIL ORGANIC MATTER IN DIFFERENT CROPPING SYSTEMS

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Introduction

In the upper soil layer organic matter is constantly being created and decomposed. The humus pool of the soil is relatively stable (Jenny 1941).
Kemenesy (1961) discriminated between humus-increasing and humus-decreasing crops, by means of which the soil organic matter pool can be maintained or increased. Uhlen (1991), Collins *et al.* (1992) and Havlin *et al.* (1990) emphasized the important role of crop rotation in maintaining or increasing soil organic matter content. It was demonstrated by factor analysis in Martonvásár that the humus content of the soil is influenced by the soil tillage system, fertilization and crop rotation, in this order (Győrffy 1975).
Humus substances are well known to influence the physical condition of the soil indirectly through the water-air ratio and the water management of the soil (Győri 1984). In soils with high organic matter contents the level of biological activity is also higher (Tate 1987). Soil microorganisms produce secretions which stabilize the soil aggregates (Cook and Ellis 1987), though other authors warn against attaching too great importance to this phenomenon, because the effect of microorganisms on aggregate stability lasts for only a short time and cannot be regarded as permanent (Dvoracsek et al., 1957).
In this paper the effect of different crop rotations and maize monoculture as well as different rate of fertilizers were studied on the vertical distribution of soil organic matter. Since soil organic matter content changes only in small measure annually its research can be done reliably only in long-term field experiments.

Methods

The study was conducted in long-term field experiments set up by the Institute of Plant and Environmental Sciences of the Georgikon Faculty of the University of Veszprém, in Keszthely, Hungary in 1963 (crop rotation) and 1969 (maize monoculture), respectively. The bi-factorial trials had four replications. The plot size is 130 m^2 in case of crop rotations and 90 m^2 in case of maize continous cropping. The soil was a Ramann-type brown forest soil (Eutric Cambisol) containing 41% sand, 32% silt, and 27% clay. The available phosphorus content of this sandy loam soil was low (AL- P_2O_5: 60-80 $mgkg^{-1}$), the potassium content medium (AL-K_2O: 140-160 $mgkg^{-1}$) and the humus content fairly low (1.6-1.7%), with a pH_{KCl} value of 7.3. Long-term annual mean precipitation was 650 mm, but the distribution was often unfavourable. The long-term mean annual temperature was 10.8 °C.
In the experiments fertilization can succeed differently in the crop rotations (winter wheat - alfalfa - alfalfa - winter wheat – maize, winter wheat - oats and vetch - winter wheat - maize - sorghum) and in the maize continuous cropping. The study was conducted on the maize grown in both of the two different types of five-year crop sequences and in continuous cropping, involving different rates of fertilizers.
In the crop rotation experiment three variants of fertilization were studied:

- control: 0 kg NPK ha^{-1},
- mineral fertilizer application: 2080 kg NPK ha^{-1} 5 yr^{-1} (in each cycle),
- mineral fertilizer application + farmyard manure (FYM): 2080 kg NPK + 35 t FYM ha^{-1} 5 yr^{-1} (in each cycle). FYM had been applied before maize every fifth year.

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In the monoculture maize cropping experiment four rates of mineral fertilizer application were studied: control (0 kg NPK ha^{-1} yr^{-1}), 300, 600 and 900 kg NPK ha^{-1} yr^{-1}. This treatments are refered in the text as NPK 0, NPK 300, NPK 600 and NPK 900.

Soil samples were collected in the maize plots at a depth of 0-300 cm after the harvest of maize in the autumn. The 0-300 cm soil layer has been split into 20 cm thick sublayers and tested in the lab. The soil organic matter content was quantified by Tyurin's method (Ballenegger and Di Gléria 1962).

Results and discussion

With a rise in the depth of soil layers soil organic matter content decreased gradually until the depth of 100-120 cm. Below this depth soil organic matter content did not changed significantly either in each of the crop rotations or in the maize monoculture (Figure 1., Figure 2. and Figure 3.).

Differences in soil organic matter content between the effect of the experimental treatments were registered in the 0-100 cm layer in case of the crop rotation that included alfalfa, while in case of the other crop rotation that was composed solely of annual crops differences were registered only in the 0-40 cm layer. In the continuous maize cropping experiment differences between the effect of the different rates of fertilizers were measured even in the 0-280 cm deep soil layer.

Fertilization resulted in higher soil organic matter content in each experiment as well as complementary FYM application did in both of the crop rotations. The highest values of soil organic matter content were measured in the fertilized and manured plots of the crop rotation including alfalfa, while the lowest values were measured in the control plots of the maize monoculture.

Contrary to the tendencies observed in case both of the crop rotations, differences in soil organic matter content were measured even under the depth of 100-120 cm in maize monoculture. In the whole 0-300 cm depth of the tested soil profile soil organic matter content as a result of the NPK 900 treatment was higher than that of the other treatments.

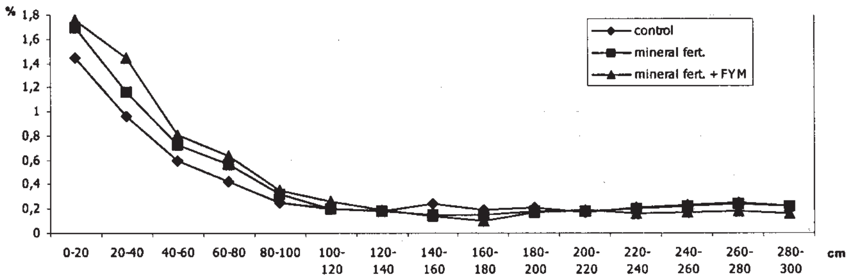

Figure 1. Vertical distribution of soil organic matter content in the crop rotation including alfalfa (w. wheat-alfalfa-alfalfa–w. wheat–maize)