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Chemical and biochemical properties of Stagnic Albeluvisols organic matter as result of long-term agricultural management and native forest ecosystem

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Soil organic matter (SOM) is considered to be as the most important factor in soil forming, development and continuous functioning. Sequestrated into SOM organic carbon concentrations, pools and residence time in soil, as well acting intensity of interconnected with SOM edaphon are soil type specific or characteristic to certain soil types. In depending on soil moisture regime, calcareousness and clay content for each soil type certain soil organic carbon (SOC) retaining capacity and its vertical distribution pattern are characteristic. However, land use change (crop rotation, continuous cropping, no-tillage, melioration, rewetting) has greatest influence mainly on fabric of epipedon and biological functions of soil cover.

Stagnic Albeluvisols are largely distributed at Tartu County. They form here more than half from arable soils. The establishment of long-term field trial and forest research area in these regions for biochemical analysis of *Stagnic Albeluvisols'* organic matter is in all respects justified.

In 1989, an international long-term experiment on the organic nitrogen or IOSDV (Internationale Organische Stickstoffdauerdiingungsversuche) with three-field crop rotation (potato - spring wheat - spring barley) was started at Eerika near Tartu (58˚22.5' N; 26˚39.8' E) on *Stagnic Albeluvisol*. The main aims of this study were to determine the long-term effects of cropping systems on physico-chemical properties of soils and their productivity. The design of this field experiment is similar to other European network of IOSDV experiments. Before the establishment of this experiment in 1989 it was in set-aside state (5–6 years) as field-grass fallow. It was used as arable land in condition of state farm during 1957–83.

Average agrochemical characteristics of the plough horizon of soil in the year of establishment were the following: humus content 17.1 g kg^{-1}, total nitrogen content 0.9 g kg^{-1}, C:N ratio 11 and pH_{KCl} 6.3. DL soluble phosphorus content was 44 mg kg^{-1} and potassium 133 mg kg^{-1}. Content of both Mg - 48 mg kg^{-1} and Ca -1090 mg kg^{-1} were determined by AL-method.

Each plot of the experiment was divided according to three treatments of organic fertilizers as follows:

(1) Without any organic manure from the beginning of the experiment (WOM);

(2) Farmyard manure 40 Mg ha^{-1} for potato (FYM);

(3) Alternative organic fertilizers in autumn before ploughing (beet leaves until 1995, since 1996 straw) (RS).

Two first organic treatments have been unchangeable since beginning of the experiment. In treatment of alternative organic fertilizers in autumn 2001, recultivation substance (RS – oil shale semi-coke mixed with sphagnum peat at voluminous ratio 1:1) 20–60 Mg ha^{-1} was applied. In autumn 2002, compost (40 Mg ha^{-1}) was applied formed from RS and solid fraction of pig slurry for potato or created from RS with town waste sludge for spring barley. RS is with alkaline reaction and has high content of K, Ca, Mg and the content of heavy metals is close to their average value in Estonian mineral soils.

Each treatment of organic manure (three in total) was divided into five mineral fertilizer treatments by nitrogen amount (0, 40, 80, 120 and 160 kg N ha^{-1}), from which in current study two variants of mineral fertilizer (0 and

120 kg ha^{-1}) were used in three replications. The combined mineral fertilizers $N_{120}P_{23}K_{57}$ for spring cereals and $N_{120}P_{55}K_{185}$ for potato were applied in spring before sowing-plantation.

The soil materials from different fertilizer treatments of arable soils (S1 - S6) and from forest (S7) were sampled in October 2003. Soil samples are marked using the numeration and the nomination as follows:

S1 – without any organic and mineral fertilizers –WOM/N-0,

S2 – direct or after effect of farmyard manure without additional mineral fertilizer – FYM/N-0,

S3 – after effect of RS or direct effect of compost made from RS with solid fraction of pig slurry or town wastewater sludge without additional mineral fertilizer – RS/N-0,

S4 – without organic manure, but using mineral fertilizer 120 kg N ha^{-1} – WOM/N-120,

S5 – farmyard manure with mineral fertilizer 120 kg N ha^{-1} - FYM/N-120,

S6 – composts from RS with mineral fertilizer 120 kg N ha^{-1} - RS/N-120,

S7 – Sample of forest soil humus horizon taken from the profile of *Stagnic Albeluvisol* located in prematured (75–85 years) *Oxalis* site-type spruce forest (situated very close to Eerika field trial at Tiksoja).

The goal of this investigation study was to reveal (a) the differences in the content and activity of biologically active substances found in SOM of arable soils under long-term continuous crop rotation fertilized with organic and inorganic fertilizers (b) to shown that natural conditions changed biochemical properties of forest soils.

These investigations demonstrate the impact of cultivated plants and kind of fertilizers on different kind of nitrogen and organic carbon and plant growth hormone (IAA), activities of enzymes participated in nitrogen cycle such as urease and nitrate reductase in soil, and also crop yields. There is considerable overlap between biochemical properties of soils and cultivation and also fertilization. We found that the application of WOM/N-120 irrespective of cultivated plant leads to the highest crop yields.