SOIL ORGANIC MATTER AND PRODUCTIVITY OF BOREAL CLAY SOILS

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Introduction

Soil organic matter plays a key role in soil functions by maintaining biological activity, increasing water holding capacity and enhancing the formation of stabile structure. Furthermore, increasing soil organic carbon (OC) is promoted as a mean to reduce the concentration of atmospheric carbon dioxide and to slow down the climate change. In this study, we aimed to find out whether increasing soil OC has measurable beneficial effects on clay soil productivity in boreal conditions that would motivate farmers to adopt practices that increase the amount of OC in soil.

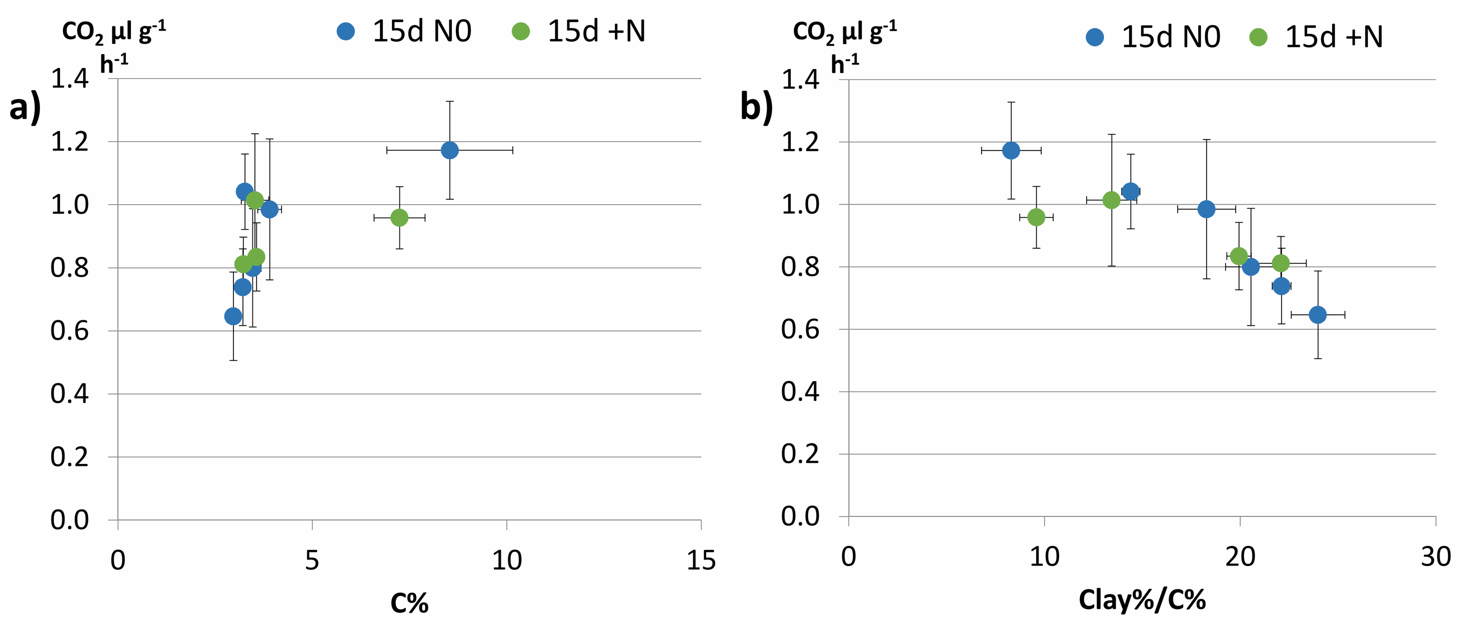

Figure 1. Respiration as µl CO_2 g^{-1} h^{-1} soil (dry matter, DM) and **a)** soil C% and **b)** Clay%/C% -ratio of soils from fertilized and unfertilized plots. Each point is an average of four separate samples taken from the same field. Error bars = standard deviation .

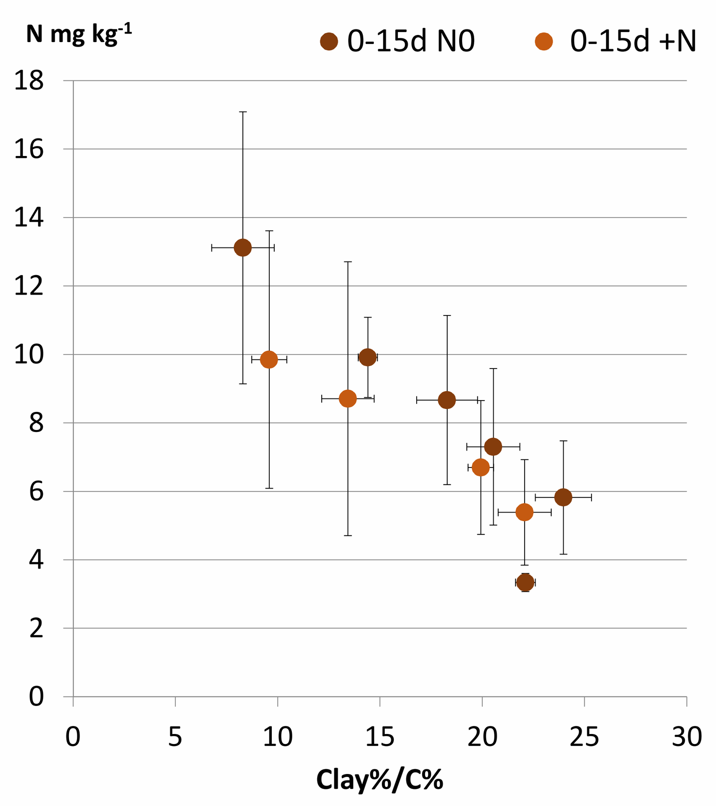

Figure 2. Net N mineralization (mg kg^{-1} DM) measured after 15 d incubation and Clay%/C% -ratio of soils taken from fertilized and unfertilized plots. Each point is an average of 4 samples from the same field. Error bars = standard deviation.

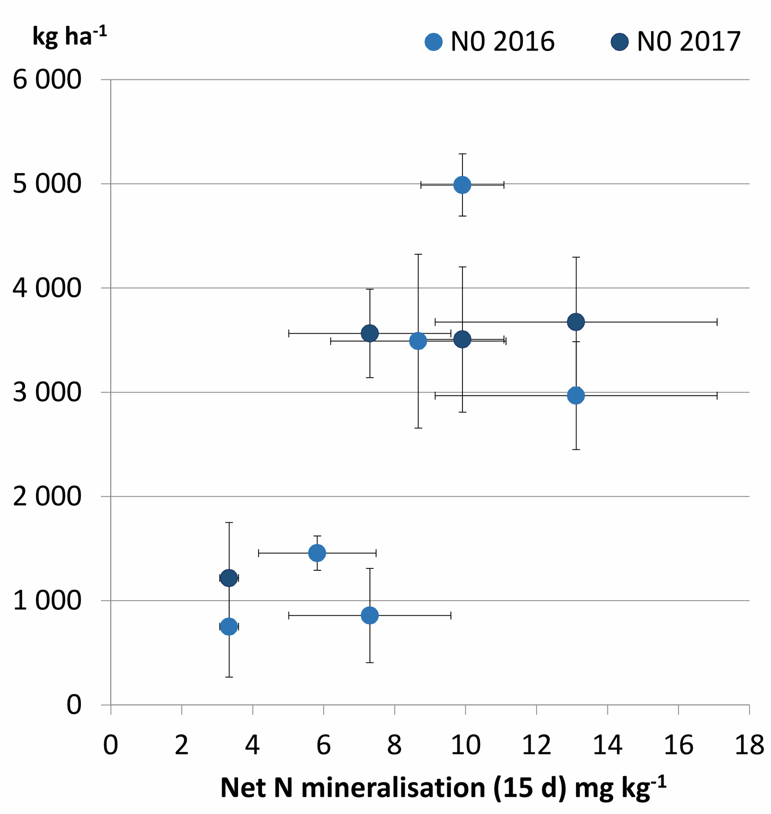

Figure 3. Yields of unfertilized plots (2016 and 2017) presented as dry mass of ears ha^{-1} and net N mineralization (mg kg^{-1} DM) measured after 15 d incubation. Each point is an average of 4 samples from the same field. Error bars = standard deviation.

Material and methods

Soil samples were collected from fields (clay >30%) in the autumn 2016 (9 fields) and 2017 (18 fields) and each field was divided into two plots: unfertilized plot and plot receiving N fertilization. From each plot, yield (reported as dry mass of ears per ha) and surface soil samples were collected from four sampling points (distance c.10 m). Soil samples were analyzed for texture, organic carbon (C%), bulk density (BD), aggregate stability (wet aggregate stability, WSA%) and colloid detachment during wet sieving (turbidity, NTU). Ten plots of which four had received N fertilization and six were unfertilized, were further sampled (four sampling points from each plot) in the autumn 2016 for an incubation experiment to study the net nitrogen (N) mineralization and respiration.

Results

In the incubation experiment, the respiration correlated positively with C% whereas Clay%/C% and respiration showed clear negative relationship (fig. 1). There was no difference in the respiration between the fertilized and unfertilized soils. The net N mineralization was negatively correlated with clay%/C% (fig. 2). For soils with higher N mineralization we measured higher yields (fig. 3), referring the Clay%/C% -ratio to have a role in the estimation of the productivity of clay soils in boreal climate.

On 2016, there was no clear relationship between C% and yield, but on 2017, the soils with higher C% were more likely to produce higher yields (fig. 4). Similarly as in the incubation experiment, the lower clay%/C% appeared to predict higher yields (fig. 5). Further, fields with high C% had lower BD and higher WSA%. The turbidity (NTU) was lower for soils with lower clay%/C% (fig. 6) referring to lower risk for erosion and loss of particulate P.

Our results suggest that for clay soils in cool and humid climate, the higher the clay content the more OC is needed to be able to produce higher yields and to enable the production in environmentally sustainable way.

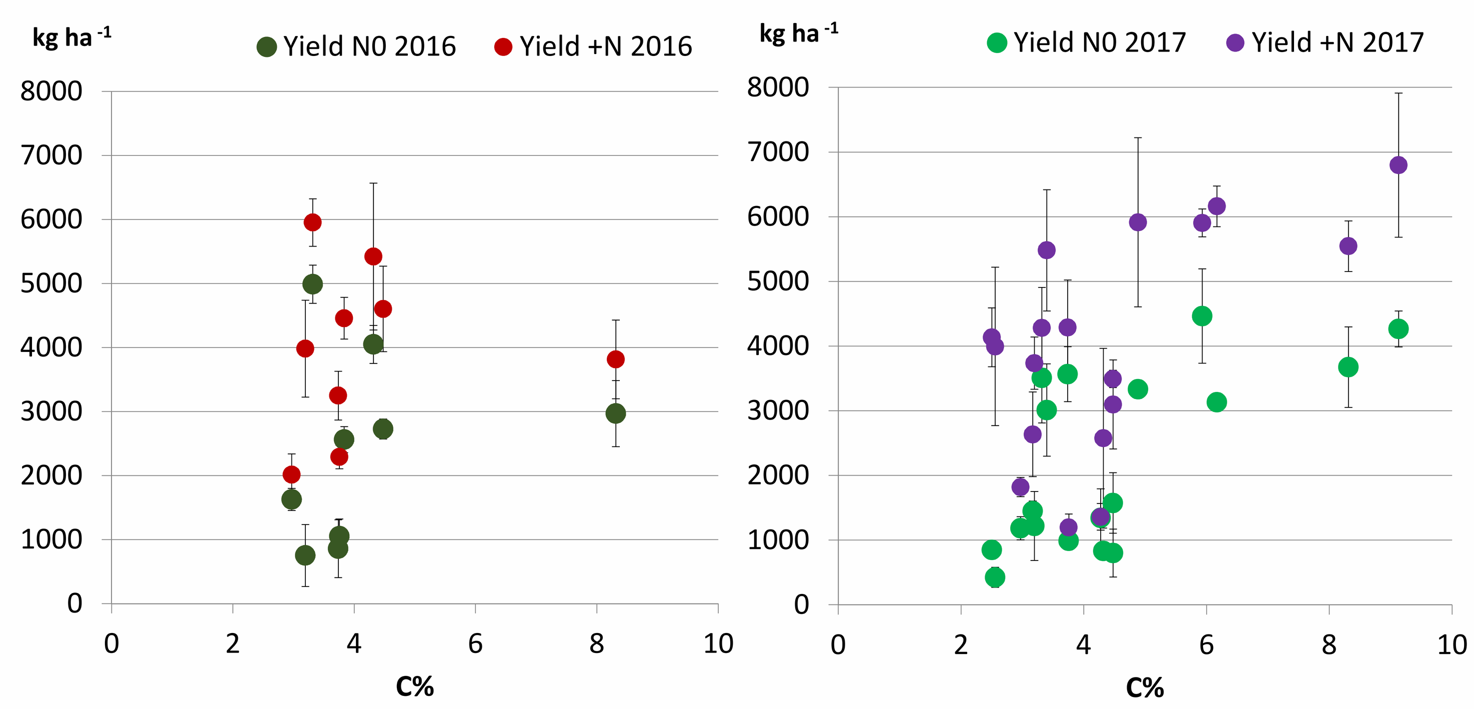

Figure 4. Relationship between soil C% and yields of fertilized and unfertilized plots (2016 and 2017) presented as dry mass of ears ha^{-1}. Each point is an average of four samples from the same field. Error bars = standard deviation.

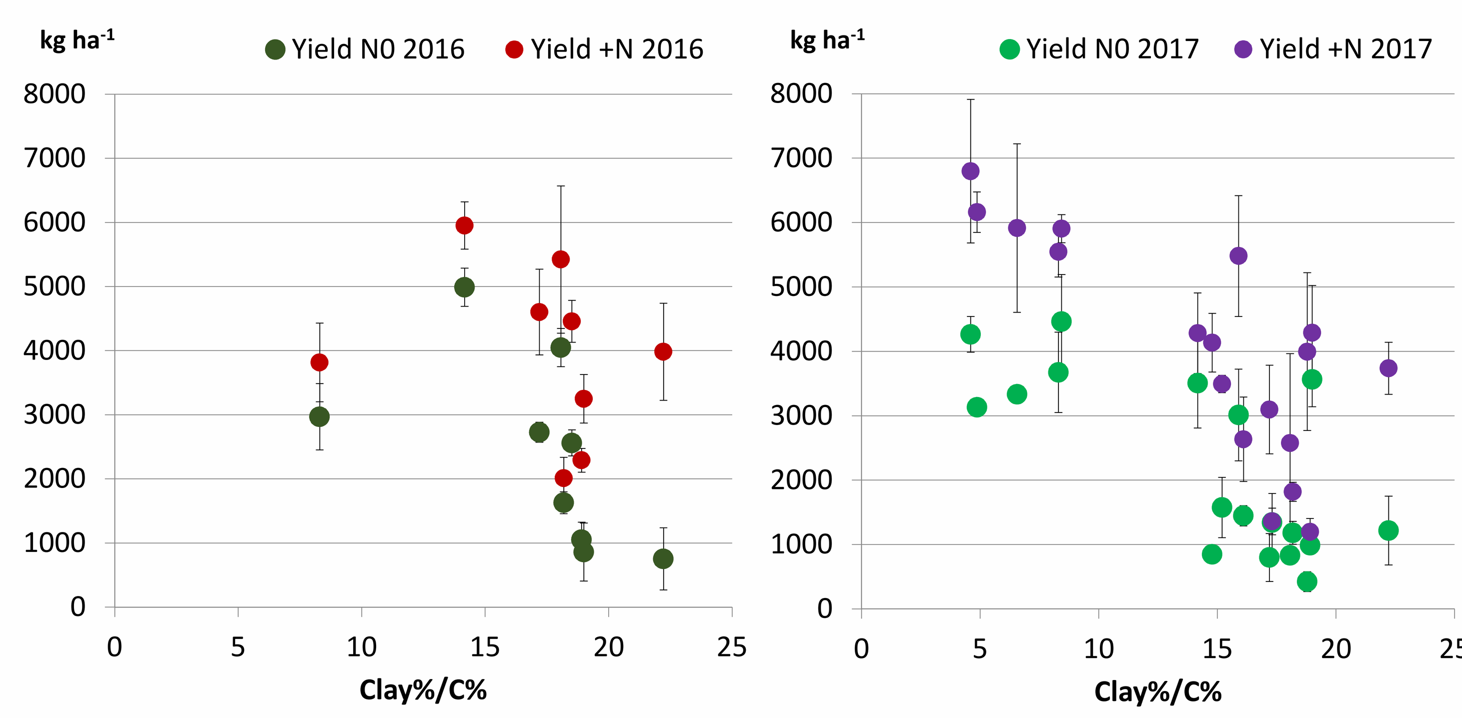

Figure 5. Relationship between Clay%/C% -ratio and yields of fertilized and unfertilized plots (2016 and 2017) presented as dry mass of ears ha^{-1}. Each point is an average of four samples from the same field. Error bars = standard deviation.

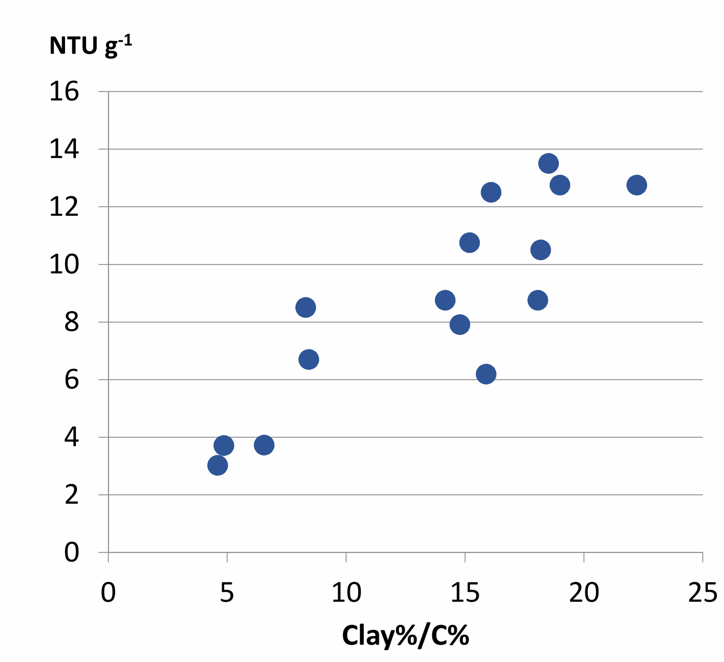

Figure 6. Relationship between soil Clay%/C% -ratio and colloid detachment (NTU) during the wet sieving. Each point is an average of four separate samples taken from the same field.