Capacity of the soil to decompose organic matter in old and young grasslands

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Abstract

To study the effect of grassland renewal on soil quality and the eco-efficiency of grass production, we compared ten young grasslands (aged 5-10 years grassland without tillage) with ten old grasslands (age >20 year grassland without tillage) as pairs on ten dairy farms on marine clay in the North of the Netherlands. On these 20 grasslands we measured the capacity of a soil to decompose organic matter. This was tested by using the Tea Bag Index (TBI). TBI is determined through the burial and retrievement of green and rooibos tea bags, following by the measurement of mass loss after 90 days. The decomposition rate k and the stabilisation factor S of young grasslands were not significantly different from older grasslands; however, variation between locations was high. A negative correlation was found between age of the grassland and the stabilisation factor S, meaning that decomposition of organic matter in older grassland continues for a longer time and may be an indication of a higher soil biological activity.

Keywords: marine clay, permanent grassland, soil organic matter, Tea Bag Index

Introduction

More and more farmers in the Netherlands plough and reseed their grasslands to improve drainage and/or to introduce the newest grass varieties. In the short term this gives a production increase, but in the long term the loss of soil quality caused by tillage could mean a reduction of production, especially with the recent legislative restrictions on the use of organic and artificial N fertilizers. Soils under grassland have advantages in soil quality in general, and specifically for carbon sequestration and soil biodiversity (Van Eekeren *et al.* 2010). As a consequence, on older grasslands with relatively high soil organic matter levels, lower inputs of N from fertilization may result in crop yields equal to those of grasslands with relatively low soil organic matter levels (Reijs *et al.* 2007; Van Eekeren *et al.* 2008). The objective of this experiment was to measure the effect of the age of grassland (old vs young) on the capacity of the soil to decompose organic matter. To test the capacity of the soil to decompose organic matter the Tea Bag Index (TBI) was used. The TBI is an innovative, cost-effective, standard method developed by Keuskamp *et al.* (2013) to gather data on decomposition rate and litter stabilisation of the soil. Since old grasslands contain, in general, a higher soil organic matter and soil biota than young grasslands it was hypothesised that the decomposition of organic matter would be higher (higher decomposition rate k and a lower stabilisation factor S) in old grasslands than young grasslands.

Material and methods

Measurements took place at 10 dairy farms on marine clay in the North of the Netherlands (Friesland and Groningen). Two grasslands were selected per farm, one young grassland (aged 5-10 years in grassland without tillage) and one old grassland (age >20 years grassland without tillage). For each plot 4 pairs of green and rooibos tea bags were buried as described in Keuskamp *et al.* (2013). (Rooibos (*Aspalathus linearis*) is a broom-like member of the legume family, of which the leaves are used to make a herbal tea.) After 90 days the tea bags were retrieved, oven dried (48 h, 105 °C) and weighed. Two parameters comprising the TBI were calculated: decomposition rate k and stabilisation factor S. The decomposition factor k is a measure for the turnover time of labile carbon. The stabilisation factor S is a measure for the

stabilisation of the decomposition of organic carbon (Keuskamp *et al*, 2013). An ANOVA procedure (Genstat 13.3, VSN international) to test for treatment effect (young versus old grassland) was used. Each of the 10 farms in which both treatments were compared was statistically regarded as a block. Apart from the treatment effect, correlations between decomposition rate k and stabilisation factor S and age of the grassland were tested.

Results and discussion

The decomposition rate k and the stabilisation factor S of young grasslands was 0.0158 and 0.224, respectively, and were not significantly different from older grasslands (k=0.0165 and S=0.208). Standard error for the decomposition rate k was 0.0014, and 0.010 for the stabilisation factor S. However, variation between the locations was high (Figure 1). The measurements took place at 10 dairy farms with the same soil type in the same climate and the same ecosystem. The amount of rain during the period that the tea bags were buried varied a little between the farms. Keuskamp *et al.* (2013) calculated the decomposition rate k and the stabilisation factor S for 100 different locations at different ecosystems and countries. Our teabags were oven-dried at 105 °C, whereas Keuskamp *et al.* (2013) dried at 70 °C. At 70 °C they found an average decomposition rate k of 0.013 (0.016 at 105 °C) and a stabilisation factor S of 0.24 (0.22 at 105 °C). Compared to their results, we found at both temperatures in most of the grasslands a higher decomposition rate k and a higher stabilization factor S (Figure 1).

At one farm we found significantly higher k rates at the young as well as at the old grassland in comparison with the other farms. This could be an effect of a different grassland management strategy on the farm. This will be further investigated in the near future. The age of the grassland and the stabilisation factor S was negatively correlated (P=0.038). This could mean that older grasslands have a higher capacity to decompose organic matter in the soil, which may be an indicator for a higher soil biological activity. No correlation was found between the age of the grassland and the decomposition rate k.

Conclusions

No significant differences in the decomposition rate k and the stabilisation factor S of organic matter were measured between young and old grasslands. A negative significant correlation between age of grassland and the stabilisation factor S could suggest a higher soil biological activity in older grasslands.

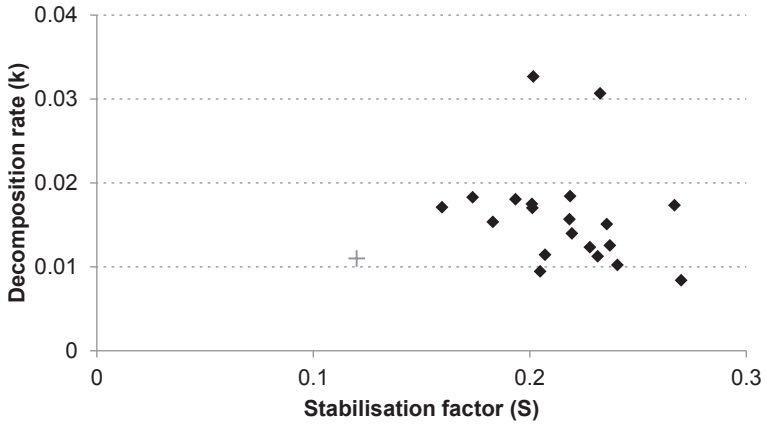

Figure 1. Stabilisation factor S and decomposition factor k for 20 different grassland sites at marine clay, and the NL pasture (the +symbol) measured by the method of Keuskamp *et al.* (2013).

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