Short communication – Kurzmitteilung
Oxidation of methane and dehydrogenase activity in a Mollic Gleysol

Małgorzata Brzezińska[1]*, Yakov Kuzyakov[2], Teresa Włodarczyk[1], Karl Stahr[2] and Witold Stępniewski[1]

[1]Polish Academy of Sciences, Institute of Agrophysics, 20-290 Lublin 27, Poland
[2]Universität Hohenheim, Institut für Bodenkunde und Standortslehre (310), D-70599 Stuttgart, Germany

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Summary – Zusammenfassung

It was found that during a 4-day incubation of a Mollic Gleysol with 352 µl l^{-1} methane in the headspace, the rate of methane consumption declined exponentially from an initial value of 9.13 µmol kg^{-1} $hour^{-1}$ (about 5% of total CO_2 evolved) according to first-order kinetics. The increase of dehydrogenase activity due to methane amendment did not exceed 15% of the control value and reached the maximum after two days of incubation.

Methanoxidation und Dehydrogenaseaktivität eines Mollic Gleysol

Die Dehydrogenaseaktivität eines Mollic Gleysols nach Methanzugabe (352 µl l^{-1}) wurde in einem 4 Tage dauernden Modellexperiment untersucht. Die Geschwindigkeit der CH_4-Oxidation nahm exponentiell von 9.13 µMol CO_2 kg^{-1} h^{-1} (ca. 5% des Gesamt-CO_2-Effluxes des Bodens) gemäß einer Reaktion 1. Ordnung ab. Die Zunahme der Dehydrogenaseaktivität unter Einfluß der CH_4-Zugabe blieb unter 15% der Kontrolle und erreichte nach zwei Inkubationstagen ihr Maximum.

Introduction

Methane is oxidized in soil by methanotrophs with the use of a chain of enzymes such as methanol, formaldehyde, formate, and non-specific aldehyde dehydrogenases (*Large*, 1983). The aim of the paper is to present preliminary data concerning methanotrophic and dehydrogenase activity in a Mollic Gleysol incubated in a methane-amended atmosphere.

Materials and methods

Soil material (Aa horizon) of pH 5.9 (in $CaCl_2$), was sampled from the experimental test site "Siggen-Neuweiher" (Germany). The soil contained 9.07% Corg, 0.86% Nt, 42% clay, 43% silt (2–63 µm) (*Kleber*, 1997). Soil passed through a 4 mm sieve was used. 300 g portions of the soil were incubated in sealed 4.5 l jars at 25°C in the dark for four days in a CH_4-amended atmosphere (352 µl CH_4 l^{-1} ± 16) with three replicates. The lids of the jars were equipped with septa and peristaltic pumps to mix the air.

Methane uptake (by gas chromatography according to *Kleber* et al., 1997), enzyme activity (according to *Friedel* et al., 1994), emission of CO_2 (by absorption in 1 M NaOH solution according to *Black*, 1965) and redox potential (with Pt electrode) were measured every 24 hours.

Results and discussion

Methane concentration in the headspace decreased exponentially, reaching 4 µl l^{-1} after four days of incubation (Fig. 1). The rate of methane consumption followed typical first-order kinetics described by an exponential equation with a time constant of 0.039 $hour^{-1}$ which corresponds to the consumption of 3.9% of the actual amount of methane per hour and a half-oxidation time of 17.8 hours.

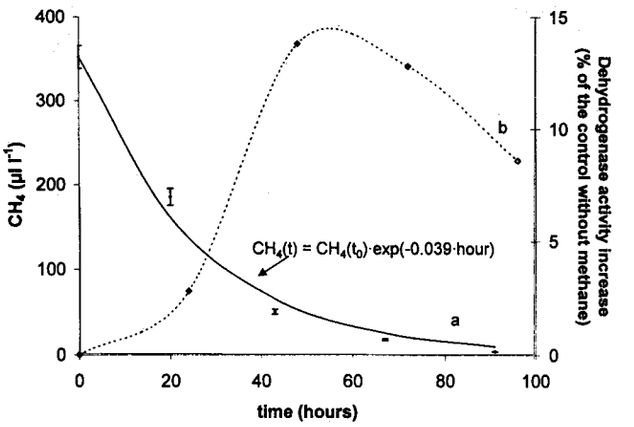

Figure 1: Development of methane concentration (± standard error) in the headspace – (a), and the methane-induced increase in soil dehydrogenase activity – (b) for the Mollic Gleysol as a function of incubation time.

Abbildung 1: Verlauf der Methankonzentration (± Standardfehler) in der Atmosphäre – (a), und die Zunahme der Dehydrogenaseaktivität des Bodens unter dem Einfluß der CH_4-Zugabe – (b) eines Mollic Gleysols als Funktion der Inkubationszeit.

Dehydrogenase activity of the soil incubated in the methane-amended atmosphere increased to a peak value of about 3.5 µmol INTF g^{-1} 4 h^{-1} after 2 days, after which it decreased slowly during the following days. The increase did not exceed 15% of the control value (Fig. 1). The differ-

* Correspondence: Dr. M. Brzezińska; E-mail mbrzez@demeter.ipan.lublin.pl

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ences were statistically significant (Student's t-test at $\alpha \leq 0.05$) on the third day of incubation.

The evolution of CO_2 was 180 μmol kg^{-1} h^{-1} at the beginning of the experiment and slightly fluctuated later without a significant effect of methane amendment. The initial methane oxidation rate during the 1st hour of incubation corresponded to about 9.13 μmol CO_2 kg^{-1} h^{-1} (assuming that all methane oxidation leads to CO_2 production). This means that only 5.1% of the total carbon dioxide produced due to soil respiration originated from methane oxidation. The contribution of CH_4 consumption to the total CO_2 production during subsequent hours of incubation was much smaller.

The values of redox potential, used here as a control parameter, oscillated around 590 mV confirming good aeration of the soil sample under experimental conditions.

It can be concluded that the results obtained by us indicate the existence of interrelation between the methane oxidation and the dehydrogenase activity; the relationship being more likely to be manifested at higher methane concentrations and longer exposure time. The contribution of methane oxidation to the total respiratory carbon dioxide production is rather low at atmospheric and close to atmospheric methane levels. Further research is needed for quantitative description of the relationship between total dehydrogenase activity (comprising different dehydrogenases) and methane oxidation.

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