ČESKÁ ZEMĚDĚLSKÁ UNIVERZITA V PRAZE
Katedra agroenvironmentální chemie a výživy rostlin

CZECH UNIVERSITY OF LIFE SCIENCES PRAGUE
Department of Agro-Environmental Chemistry and Plant Nutrition

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Sborník z 26. mezinárodní konference

RACIONÁLNÍ POUŽITÍ HNOJIV

zaměřené na nové trendy
ve vývoji a aplikaci hnojiv

Proceedings of 26th International Conference on

REASONABLE USE OF FERTILIZERS

dedicated to new trends
in the development and application of fertilizers

ČZU v Praze
3. 12. 2020

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Na organizaci konference se podílejí:

Katedra agroenvironmentální chemie a výživy rostlin ČZU v Praze

Ústřední kontrolní a zkušební ústav zemědělský

Zemědělská společnost při ČZU v Praze

Ministerstvo zemědělství České republiky

Ústav agrochemie, půdoznalství, mikrobiologie a výživy rostlin, Mendelova univerzita v Brně

Katedra agrochémie a výživy rastlín SPU v Nitre

Katedra chemii rolnej i środowiskowej URHK w Krakowie

Hlavní sponzoři konference:

Konference je zaměřena na nové trendy ve vývoji dusíkatých hnojiv a dále na moderní aplikační technologie. Diskutována je problematika hnojiv s inhibitory nitrifikace, s inhibitory ureázy i hnojiv s přídavkem zeolitů. Pozornost je dále věnována uplatnění humínových látek ve výživě rostlin, mikrobiálním stimulantům i „nano-látkám“. Akcentována je také otázka cíleného zonálního hnojení.

ISBN 978-80-213-3054-2

EMISSIONS OF METHANE AND CARBON DIOXIDE DURING COMPOSTING AND VERMICOMPOSTING OF SEWAGE SLUDGE

(Emise methanu a oxidu uhličitého po kompostování a vermikompostování čistírenských kalů)

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Abstract

The objective of this study was to evaluate the emissions of methane (CH_4) and carbon dioxide (CO_2) during thermophilic composting and vermicomposting of sewage sludge. Four treatments were set up (1) 100% sewage sludge, (2) 75% sewage sludge + 25% pelletized wheat straw (w/w), (3) 50% sewage sludge (w/w) + 50% pelletized wheat straw (w/w), (4) 25% sewage sludge + 75% pelletized wheat straw (w/w). All the treatments were transferred to fermenter barrels for 60 days for composting and also the same treatments used in composting were transferred to worm-bins for vermicomposting. CH_4 and CO_2 concentration in the gas phase released from treatments were measured. The results indicated that both thermophilic composting and vermicomposting produces a significant amount of CH_4 and CO_2 emissions from all treatments.

Key words: biological treatments; biosolids; greenhouse gases; earthworms

Sewage sludge is produced as a by-product during municipal wastewater treatment, and its large amounts produced in the past decades represent a rising challenge for waste management. Waste handling sector belong to major sources of greenhouse gas emissions that have a negative impact on the quality of life, ecosystems and human health. The adoption of aerobic treatment techniques like composting and vermicomposting for treatment of organic wastes seems to be the most sustainable option. Composting and vermicomposting systems are environmentally and economically favourable options for treatment and management of organic wastes. Methane (CH_4) and carbon dioxide (CO_2) are two of the most important greenhouse gases in atmosphere. Methane is radiatively stronger than CO_2 on a mass basis and it was reported that the current global warming potential of CH_4 was 25 times higher than that of CO_2 over a 100 year period [1]. Most of previous studies on composting and vermicomposting were focused on the feasibility for different organic wastes, the factors affecting the growth and reproduction rate of earthworms, as well as the quality of composts and vermicomposts [2, 3]. But, little is known about the emissions of CO_2 and CH_4 during composting and vermicomposting of particularly sewage sludge. Therefore,

the objective of this study is to evaluate the emissions of CH_4 and CO_2 during composting and vermicomposting of sewage sludge.

Material and Methods

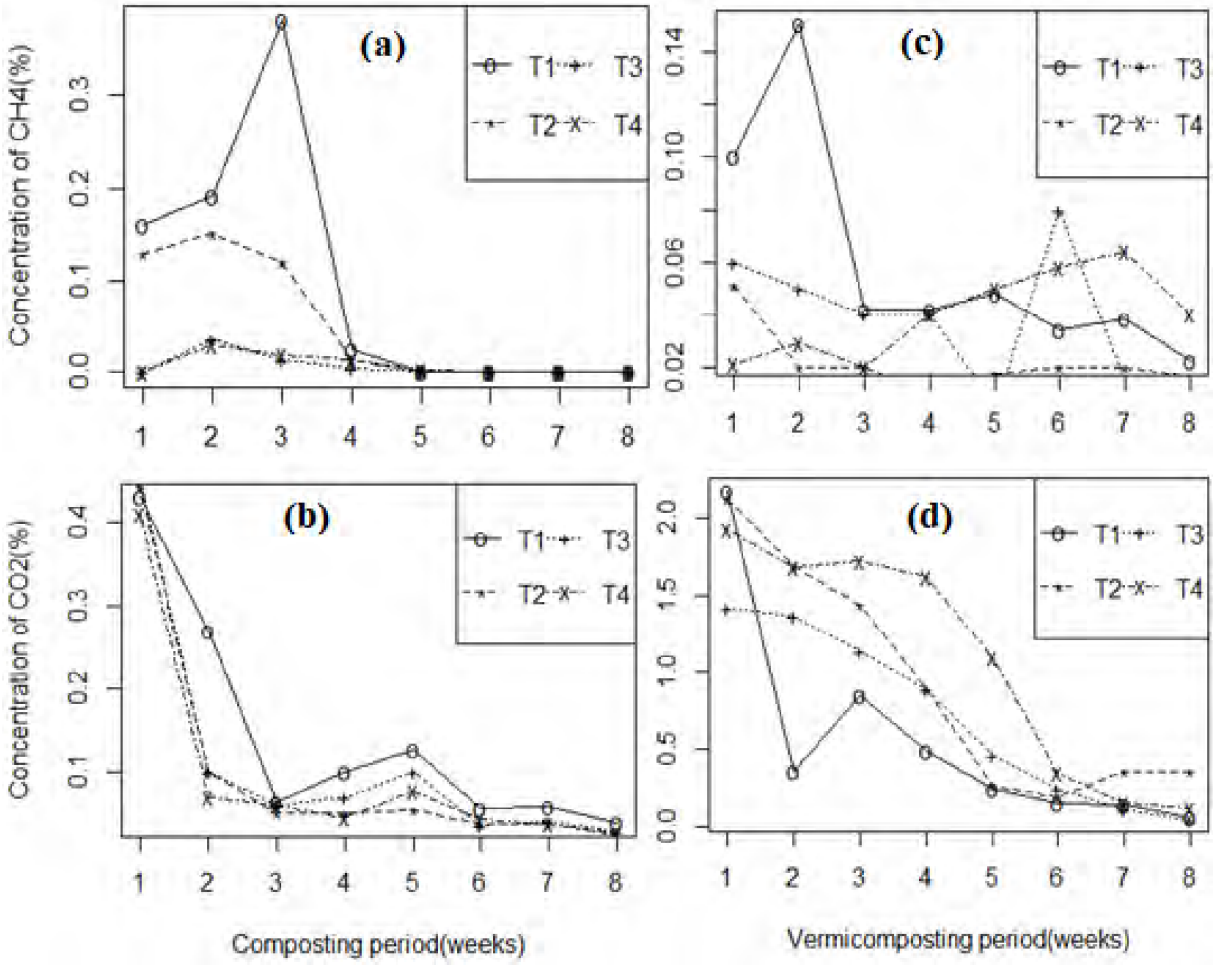
The experiment was carried out at experimental station of Faculty of Agrobiology, Food and Natural Resources, Czech University of Life Science Prague in Cerveny Ujezd, spring 2020. Sludge used for the experiments was collected from Mnichovice wastewater treatment plant, Czech Republic. Dried pelletized wheat straw with diameter of 10 mm was provided by a Granofyt Ltd Company. The experiment included four treatments: (T1) 100% sewage sludge, (T2) 75% sewage sludge + 25% pelletized wheat straw (w/w), (T3) 50% sewage sludge (w/w) + 50% pelletized wheat straw (w/w), (T4) 25% sludge + 75% pelletized wheat straw (w/w). The pelletized wheat straw was applied on a wet weight basis. In all the treatments, the substrate was homogenized and transferred to fermenter barrels for 60 days for composting and also the same treatments used in composting were transferred to worm-bins for subsequent vermicomposting for 60 days. Each worm-bin received 375 pieces of earthworms (*Eisenia andrei*) with 3 L of substrate. The moisture level of the material was maintained at about 70-80% of wet mass throughout the vermicomposting stage by spraying the surface with water at two-day intervals.

Measurements of CO_2 and CH_4 concentration during composting and vermicomposting**:** Concentration of CO_2 and CH_4 during both composting and vermicomposting were measured by a closed chamber technique. One side tip of plastic tube was connected into closed barrels for composting and worms bin for vermicomposting by a tight fit lid with two ports for headspace gas sampling and for measurement of air temperature and the other side tip of plastic tube was connected with instruments during data recording. Gases measurements were done twice per day within 12hrs intervals for 60 days by using Gasko Infrared Gas Analyzer [4].

Results and Discussions

CH_4 and CO_2 from all treatments during the composting and vermicomposting processes are displayed in Fig. 1. Results of this study showed that CH_4 and CO_2 concentrations for all treatments peaked relatively early in both composting and vermicomposting process within the 1-2 weeks after which emission rates gradually declined until the end of the experiment. Therefore it could be assumed that also the CH_4 and CO_2 emissions should be the highest during the start of the process.

1. Concentration of CH_4 and CO_2 during composting (a, b) and vermicomposting (c, d)



From treatment one (T1) the CH_4 and CO_2 peak was observed on week 1 than the other treatments during both composting and vermicomposting process and thereafter the values gradually decreased until the end of experiments. But CH_4 concentration was greatly lower than CO_2 concentration. Several researchers reported similar result that the maximum emissions of CO_2 and CH_4 occurred at the beginning of the composting and vermicomposting processes [5, 6].

In agreement with this finding, earthworms have been found to decrease CH_4 emissions by > 40% during 32-days vermicomposting of manure [7] and decrease methane emissions by 22-26% during 45-days vermicomposting of vegetable waste [8]. Generally the results indicated that both thermophilic composting and vermicomposting produces a significant amount of CH_4 and CO_2 emissions from all treatments.

Conclusion

The composting and vermicomposting processes during sewage sludge emit a considerable amount of CH_4 and CO_2, the main environmental threat to global climate change. The highest values were at the beginning of the experiment and

gradually decreased. The emission of CH_4 and CO_2 during composting and vermicomposting is linked to the fate of C present in the waste substrate.

Financial support for this work was provided by the Ministry of Agriculture of the Czech Republic under the NAZV project number QK1910095.

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Author:	Collective of authors
Name:	REASONABLE USE OF FERTILIZERS Conference Proceedings
Editor in Chief:	Prof. Ing. Václav Vaněk, CSc.
Editors:	Prof. Ing. Jiří Balík, CSc., dr. h. c. Prof. Ing. Pavel Tlustoš, CSc., dr. h. c.
Handling Editors:	Ing. Michal Jakl, Ph.D. Prof. Ing. Daniela Pavlíková, CSc.
Conference Name:	26th International Conference REASONABLE USE OF FERTILIZERS
Location:	Czech University of Life Sciences Prague, Dec 3, 2020
Publisher:	Czech University of Life Sciences Prague Faculty of Agrobiology, Food and Natural Resources Department of Agro-Environmental Chemistry and Plant Nutrition
Print:	Powerprint s.r.o., Prague
Number of Pages:	172
Publication Year:	2020
Edition:	first

ISBN 978-80-213-3054-2

Název: RACIONÁLNÍ POUŽITÍ HNOJIV
Sborník z konference
konané na ČZU v Praze dne 3. 12. 2020

Vydala: Česká zemědělská univerzita v Praze
Fakulta agrobiologie, potravinových a přírodních zdrojů
Katedra agroenvironmentální chemie a výživy rostlin

Autor: Kolektiv autorů

Lektor: Prof. Ing. Václav Vaněk, CSc.
Prof. Ing. Jiří Balík, CSc., dr. h. c.
Prof. Ing. Pavel Tlustoš, CSc., dr. h. c.

Do tisku připravili: Ing. Michal Jakl, Ph.D.
Prof. Ing. Daniela Pavlíková, CSc.

Tisk: Powerprint s.r.o., Praha

Náklad: 250 výtisků

Počet stran: 172

Rok vydání: 2020

Vydání: první

Dopor. cena: neprodejné

ISBN 978-80-213-3054-2