EFFECT OF MUNICIPAL SEWAGE SLUDGES ON CO_2 PRODUCTION OF SOIL

Csaba Varga - Zsuzsanna Uri

College of Nyíregyháza Technical and Agricultural Faculty Department of Land and Environmental Managment, H-4400 Nyíregyháza, Kótaji Str. 9-11. HUNGARY, e-mail: urizs@nyf.hu, vargacs@nyf.hu

Abstract: *CO_2 production of soil from variously treated municipal sewage sludges from three big cities in Hungary was studied in pot experiment. Although all the three sewage sludges resulted higher CO_2 production in soil than the control treatment, but no significant difference was found between the effect of sludges dosage rates on the soil CO_2 production.*
Key words: *CO_2 production, municipal sewage sludge, fodder pea (Pisum sativum L.), heavy metal*

1. INTRODUCTION

Sewage sludges are unavoidable by-products of sewage treatment. Controlled agricultural utilization of sewage sludges – in accordance with EU directions - is preffered in Hungary (PÁLNÉ, 1996). Municipal sewage sludges are rich in plant nutrients (nitrogen, phosphorus, trace elements), humusforming and soil-ameliorative substances, which are increasing the fertility of arable soils. Beside beneficial substances various toxic materials are also present in municipal sewage sludges, among which heavy metals (Cd, Hg, Pb, Zn, etc.) and organic micro-pollutants are the most dangerous (VERMES, 2003). Depending on their origin there is a great variation in heavy metal concentrations of municipal sewage sludges. Uncontrolled amendment of arable soils with sewage sludges may results in excessive accumulation of heavy metals in soil, and through soil-plant system these dangerous materials can get into the food chain.

Moreover negative effect of heavy metals, dosed out with sludges and accumulated in soil, means an additional danger on soil microbiological processes. The 2/3 part of the bioproduced CO_2 derivated from the microbiol activity and 1/3 part of it derived from root-respiration of plants (LUNDEGARDTH, 1923-24). The decay of organic matters enhances the above mentioned CO_2 production int he soil. CO_2 has a dual porpose in soil. On one hand it joins to the water content of the soil and they create H_2CO_3, which helps the chemical

weathering process. On the other hand the CO_2 serves as a carbon source for autotrophic and heterotrophic organisms. The quantity of produced CO_2 depends on soil moisture content (DAVIDSON et al., 2000; SAVAGE és DAVIDSON, 2001; 2003; PIAO et al., 2000), soil temperature (ZISKA, 1998), amount of microbes (PÁNTOS-DERIMOVA, 1983). Since the

2. MATERIALS AND METHODS

Controll (non-polluted) soil used in our pot experiments originated from the top 0-30 cm layer of the experimental site belongs to the College of Nyíregyháza. The main characteristics of these neutral, loamy sand textured brown forest soil (URI et al., 2003b) met the criterias of 50/2001 Order of Council, and the concentration of poisoning elements (URI et al., 2003a) in that soil did not exceed the limiting value.

The effect of treated municipal sewage sludge on the CO_2 production of soil was studied in our experiments. The sewage sludges originated from three Hungarian cities, such as Nyíregyháza, Debrecen and Miskolc. The heavy metal concentration of sludges, which has been already published (URI et al., 2003a; URI et al., 2003b), was low enough allowing their agricultural utilization.

This current pot experiment, where we used fodder pea as test plant, could be regarded as the continuation of our previous experinets (URI et al., 2003a; URI et al., 2003b), carried out with rye, Sudan grass and fodder rape test plants. Pots were placed into a controlled area plant-growing room of College of Nyíregyháza. Test plants were grown up on non polluted brown forest soil (it meant the control treatment) and on soil-sludge mixtures. These mixtures contained sewage sludges from the three cities separately. The rates of sewage sludges in the mixtures was 10 and 15 %. Sluedges were added to soil 2 weeks before sawing of test plants. The test plants were harvested 60 days after sawing (Figure 1).

The CO_2 production was measured in laboratory after 2-hours incubation period according to WITKAMP (1966 cit. SZEGI, 1979). Based on this method 10 ml 0,1n NaOH was measured into a 25 ml beaker glass and placed on the soil surface of the pots. Every beaker glass was covered immediately by a bigger glass to avoid the NaOH losses. After the incubation period the NaOH was titrated with HCl in presence of fenolftalein and after discolouration it was titrated with HCl in presence of metilorange indicator. The difference of the lost HCl quantity during the two titration was multiplying with the titre of NaOH and of HCl and 2,2. It gives the quantity of CO_2 production. During the experiments CO_2 production was detected ten times.

Fig. 1. 60 days old test plants just before harvesting

3. RESULTS AND DISCUSSION

It could be seen form Figure 2 that in case of sewage sludge originated from Nyíregyháza 10 % dosage rate of sludges had the most advantageous effect on CO_2 production. The lowest value was given by control treatment. These figures is applied with equal force to sewage sludge originated from Debrecen (Figure 3).

In case of sewage sludge originated from Miskolc the 15 % dosage rate application resulted the highest CO_2 production in soil, followed by 10 % dosage rate and control treatment (Figure 4).

To sum up the examined sewage sludges increased the soil CO_2 production significantly both the 10% and the 15 % dosage rate in compare to control treatment. The difference found between the effect of the two applied dosage rates on soil CO_2 production were no significant.

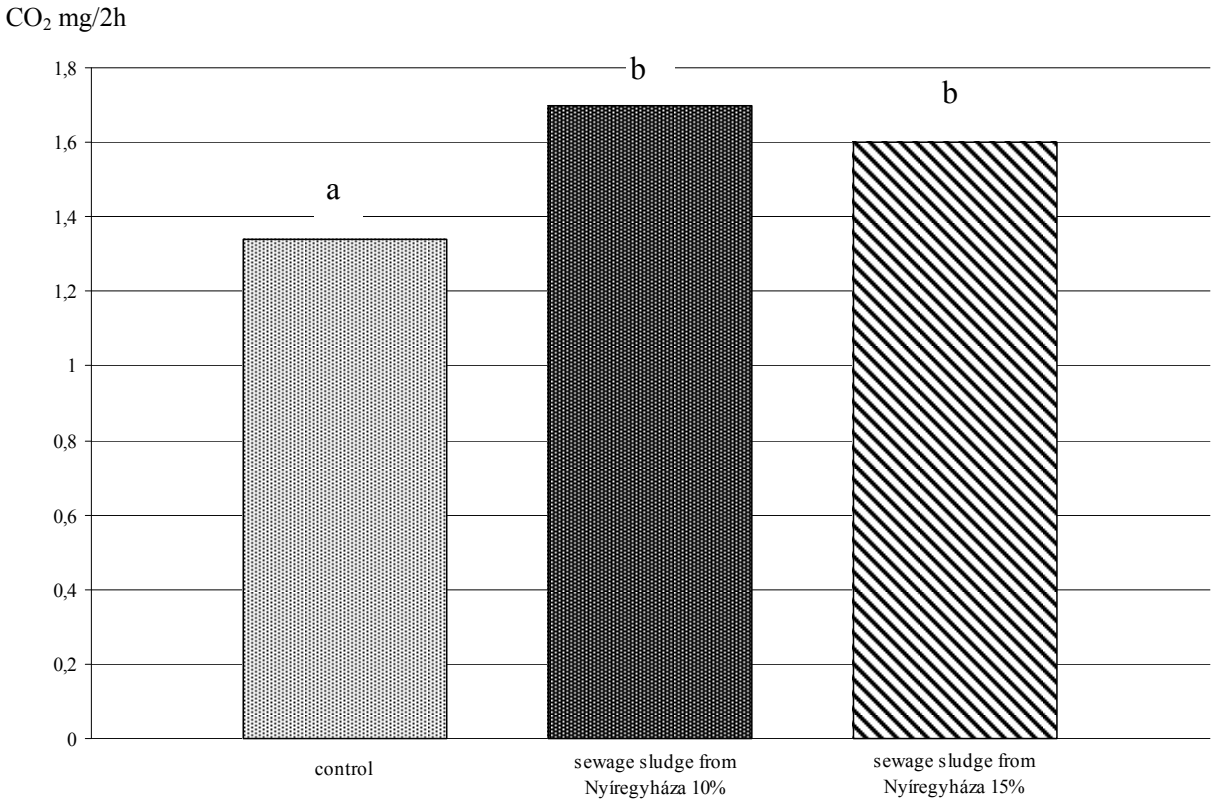

Fig. 2. Effect of municipal sewage sludge from Nyíregyháza on CO_2 production of soil

Note: Values indicated with different letters are significantly different at $P<0.05$

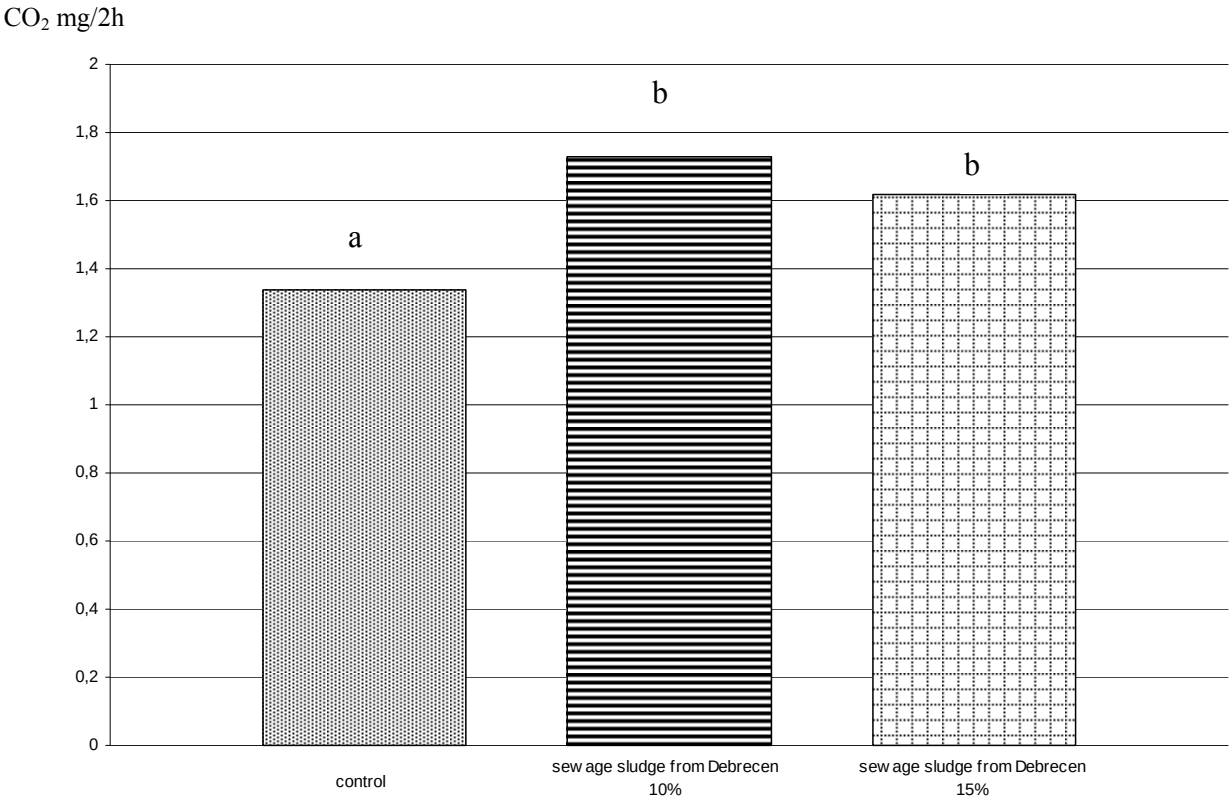

Fig.3. Effect of municipal sewage sludge from Debrecen on CO_2 production of soil
Note: Values indicated with different letters are significantly different at $P<0.05$

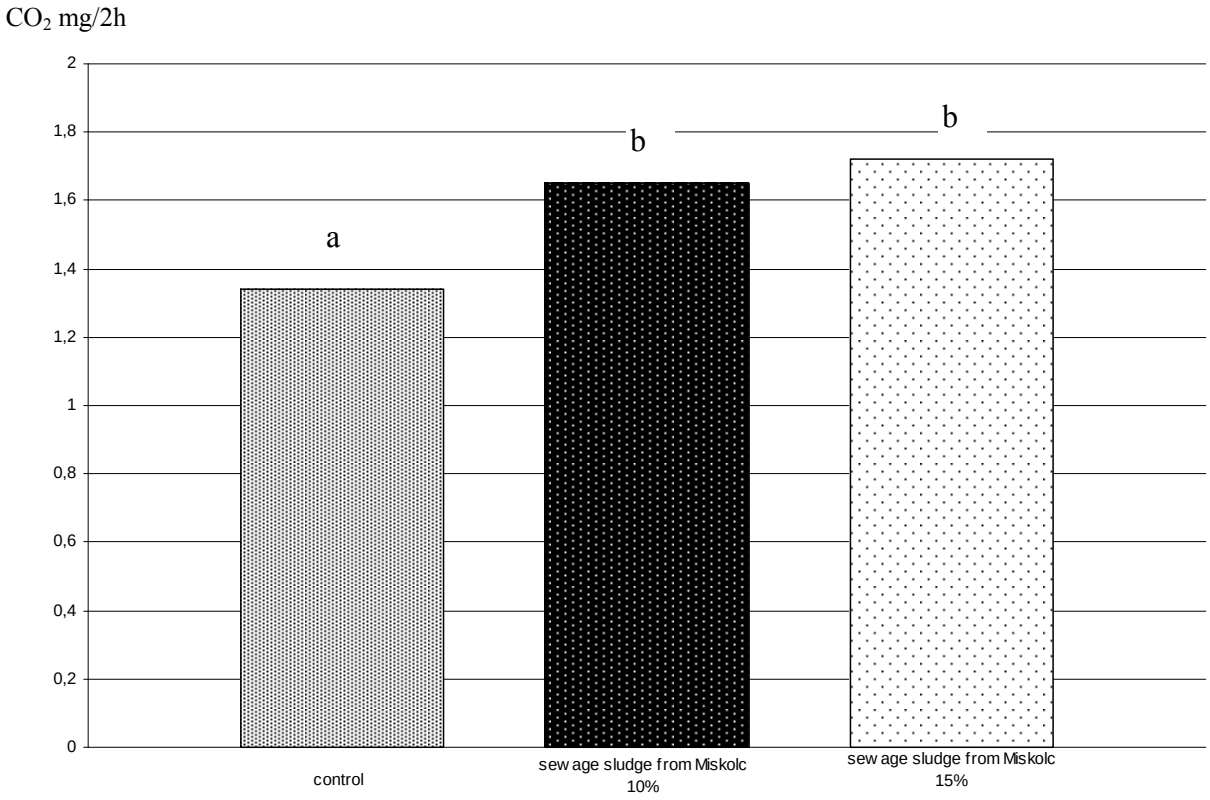

Fig.4. Effect of municipal sewage sludge from Miskolc on CO_2 production of soil
Note: Values indicated with different letters are significantly different at $P<0.05$

4. CONCLUSIONS

Application of sewage sludges increased the soil CO_2 production in compare to control treatment. In our opinion this advantageous effect is due to the high organic matter and low heavy metal contant of sludges. According to our experiments, based on measuring of soil CO_2 production it could be said that the professional agricultural application of municipal sewage sludges could have positive effect on soil life, which is very important in terms of soil fertility.

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