EFFECT OF BENTONITE AND ZEOLITE ON THE AMOUNT OF SOME MICROBIOLOGICAL PARAMETERS OF AN ACIDIC HUMIC SANDY SOIL

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Abstract

In a pot experiment, the effect of increased dosages [5; 10; 15; 20 g kg soil^{-1}] of bentonite and zeolite was studied on five soil microbiological properties of an acidic (pH_{H2O}=5.65) humic sandy soil.
In the betonite treatments increased the total number of bacteria and nitrifying bacteria number significantly. The medium-dose of betonites was the most stimulating treatment.
In the zeolite treatments the CO_2-production of soil changed only significantly. Among the five examined soil microbial parameters in three, the medium-dose proved to be the most stimulating.
The total number of bacteria, the microscopic fungi, and nitrifying bacteria increased in the zeolite treatments significantly in a larger scale, than in the bentonite treatments. The medium dose of bentonite proved to be more effective in case of cellulose-decomposing bacteria. Regarding the soil respiration, we were not able to state distinction between the effects of the two natural amendments.

Keywords: bentonite, zeolite, microbiology, acidic sandy soil

INTRODUCTION

Nowadays, the term of ”sustainable agriculture” is widely used in worldwide, which is either keystone of the rational utilization one of our most important natural resources, the soils. One of the important aim of “sustainable agriculture” is the protection and maintenance of the diverse functions of soils (Várallyay, 2005). Satisfying these requirements, the use of natural materials in soil amelioration (Balogh, 1999) such as alginite (Solti, 1987), zeolite (Köhler, 2000), or bentonite (Márton & Szabóné, 2002; Makádi et al., 2003) was increased.

For preservation and sustainability the productivity of soil we have to take special regard to the sandy soils having unfavourable properties. These soils have very low colloid contents, their water management is extreme due to the weak structure with only transmission pores, and the nutrient management is also pour (Henzsel, 2008). According to Lazányi, (2003) the natural soil amendments for acidic sandy soils can arrange into three groups: 1. green manure and other organic matter, 2. farmyard manure and different composts, 3. mining soil improving material originating from mining industry, e.g. alginite, bentonite, zeolite.

The bentonite is a rock containing clay minerals, mainly smectites (Pártai et al., 2006). The primary effect of bentonite is to improve the water holding capacity and moisture content of soil and through this property contribute to the stimulation of biological activity (Shimmel & Darley, 1985; Usman et al., 2005; Lazányi, 2005). When mix the bentonite with soil, increase the mineral nutrient content, the colloid content of soil, and with the higher colloid content decrease the leaching of different nutrients (Noble et al., 2000).

The zeolites is crystalline hydrous aluminiosilicates, the two main important mineral of it the clinoptilolite and mordenite tectosilicates (Mátyás, 1979). In plant growing experiment where the zeolite was used as nutrient supply, decreased the acidity of soil, favourably influenced the micro-elements supply (Ghrair et al., 2008), moreover helped for plants in the water lifting, and improved water management of soil (Pisarovic et al., 2003).

In a pot experiment the effect of increased dosages of bentonite and zeolite [5; 10; 15; 20 g kg soil^{-1}] was studied on some microbial dynamic an acidic (pH_{H2O}=5.65) humic sandy soil.

MATERIALS AND METHODS

The pot experiment was set up in 2007-2010 in the UD CASE Department of Agrochemistry and Soil Science in three repetitions, in six kilogram pots, on acidic (pH_{H2O}=5.65) humic sandy soil. The treatments were the same with the increased doses of bentonite and zeolite (Table 1). The water content of treatments was in the same level, as the 70% of the maximum water capacity. The pots were sprinkled in every day to the same weigh. The test plant was perennial ryegrass *(Lolium perenne L.).*

As basic treatment 100 mg nitrogen – $Ca(NO_3)_2$ solution – 100 mg P_2O_5 and 100 mg K_2O solution of potassium dihydrogen orthophosphate and potassium sulphate to every pot. Soil samples were taken in the fourth the eight week of the experiment in every year.

Among the microbiological parameters the total numbers of bacteria (in meat soup agar) and the number of microscopic fungi (in peptone glucose agar) was determined by plate dilution method according to Szegi, (1979). The number of aerobic cellulose decomposing and nitrifying bacteria was determined (Pochon & Tardieux, 1962) with the MPN (Most Probable Number) method in liquid culture media and the further parameters were the soil respiration was determine after ten days incubation (Witkamp, 1966. cit. Szegi, 1979). Statistical analysis of the data was done using the program SPSS 13.0. Means of the measurements, deviation, significance values (p=5) were calculated (Huzsvai, 2004).

Table 1

Treatments and their designation in the tables (2007-2010)

Treatments and doses	Doses	
	BENTONITE	ZEOLITE
1. Control	0	0
2. Little dose	5g kg^{-1}	5g kg^{-1}
3. Middle dose	10g kg^{-1}	10g kg^{-1}
4. Middle-large dose	15g kg^{-1}	15g kg^{-1}
5. Large dose	20g kg^{-1}	20g kg^{-1}

RESULTS AND DISCUSSION

The results are discussed according to the average values of the four years of experiment (Table 2).

The total number of bacteria increased by the effects of all the bentonite and zeolite doses. In the course of the four years all the bentonite doses caused a significant increasing in the value. In case of the bentonite the middle dose was the most stimulating, the effect of this treatment significantly differed from the effect of the other doses. The middle-large and the large doses also increased the number of bacteria, in the effects of these treatments did not differ statistically from each other.

In course of the zeolite treatments we experienced significantly increasing only by the effect of the small and middle doses. The middle dose was the most efficient. The middle-large and the large doses did not cause significantly change compared to the control. We experienced a small-scale increasing in their case.

Both natural substances with the allocation into the soil the total number of bacteria rose by the effect of the middle dose in the largest measure. The zeolite treatments significantly increased the number of bacteria in a bigger-scale, than the bentonite treatments.

The number of the microscopic fungi was growing of the average in four examination years by the little and middle doses. The small-dose bentonite significantly raised the total number of fungi. We saw near the middle-dose increasing in the values while the middle-large and large-doses reduced the fungi number. The measure of the decrease proved to be significant by the large-dose.

The small and medium doses of zeolite significantly increased the number of microscopic fungi. The medium dose increased the fungi number significantly larger scale compare to the little dose. Besides the middle-large dose the increase of fungi number was small-scale; concerning the large-dose amendment small-scale decrease was measured. A significant difference was not experienced between the control and the two large treatments. In case of bentonite the small dose of treatment, in case of the zeolite, the medium dose proved to be most stimulating. The microscopic fungi number was significantly higher by the effect of medium dose of zeolite, than the small dose of bentonite.

The cellulose-decomposing bacteria significantly increased by the effect of the small- and medium doses of bentonite. The small-dose bentonite nearly duplicated the bacteria number, the medium dose caused nearly three fold cellulose-decomposing bacteria number. We established a little-measure increase due to the medium-large dose. The large dose of bentonite – but not significantly – decreased their number.

All of the zeolite treatments raised the cellulose-decomposing bacteria number, but we established significantly increasing only at the middle- and middle-large doses. We did not experience a difference however in the effect of the doses. Our results proved that the bentonite significantly raised the bacterium number in a bigger measure, than the zeolite.

The number of nitrifying bacteria increased in all the bentonite treatments. The medium-dose caused the increase in the largest measure. Between the middle-large and large bentonite-dose we did not find significantly different.

The zeolite – except the large-dose – also enlarged the nitrifying bacteria number. We established significant increase their number at the small and middle doses. At the large dose of zeolite we observed small-value decrease. The bentonite treatments proved to be more effective regarding to the nitrifying bacteria number, than the zeolite.

Table 2

Effects of treatments on the examined soil microbiological parameters on acidic sandy soil (average values of the four experimental years, 2007-2010)

Treatments		Total number of bacteria (*10^6 g^{-1} soil)	Total number of fungi (*10^3 g^{-1} soil)	Cellulose-decomposing bacteria (*10^3 g^{-1} soil)	Nitrifying bacteria (*10^3 g^{-1} soil)
Bentonite	1	2.56 a	55.58 a	2.63 a	1.11 a
	2	**4.01** b	**59.21** b	**4.85** b	**2.23** b
	3	**5.45** c	56.38 a	**6.24** c	**2.72** c
	4	**4.54** bc	55.33 a	3.25 a	**1.56** d
	5	**4.79** bc	**49.08** c	2.04 ab	**1.50** d
Zeolite	2	**5.85** bc	**62.21** d	3.39 a	**2.02** b
	3	**7.04** bcd	**66.42** e	**3.65** ad	**2.41** be
	4	3.21 ab	57.75 ab	3.79 ad	1.21 a
	5	3.09 ab	53.75 a	3.14 ad	0.85 af
LSD5%		1.25	2.25	0.81	0.27

In the bentonite-treatments the CO_2-production of soil changed during the four experimental years between 4.23-5.56 mg $100g^{-1}$, at the zeolite-treatments 4.34-6.20 mg $100g^{-1}$ (Figure 1).

At the bentonite-treatments compared to the control we established, that the little dose and the medium dose significantly enlarged the CO_2-production of soil. Near the medium-large dose we saw a low-value increase, at the large dose a low-value decrease was determine. Regarding to the soil respiration the bentonite medium dose was the most effective treatment, but their effect was not different from the effect of the little dose.

In all zeolite-treatments the soil-respiration increased. Except for the little dose, the value of the soil respiration was significantly larger than the control soil. However between the effects of doses there was not a difference which can be justified statistically. The largest CO_2-production was measured in the medium-large doses.

Regarding to the CO_2-production there was not difference between the effect of bentonite and zeolite, the zeolite – not significantly – enlarged the soil respiration in a bigger measure, than the bentonite.

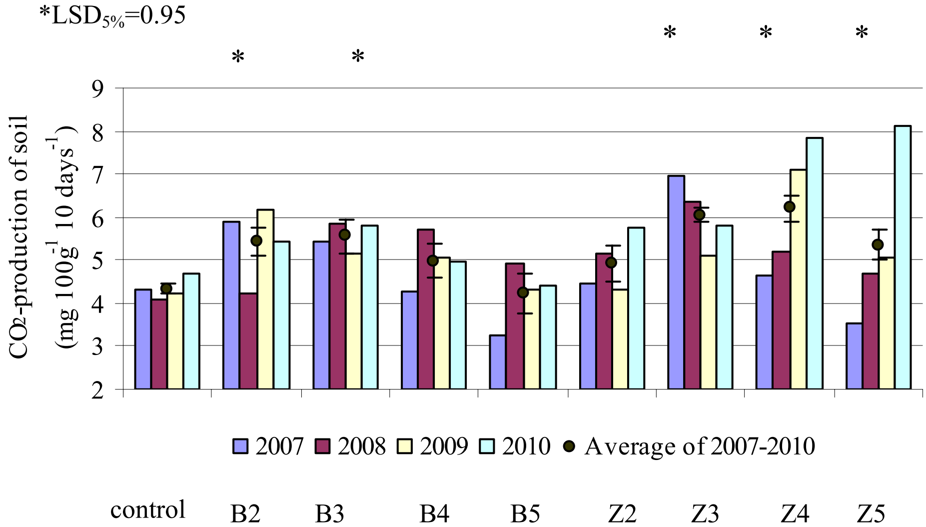

Fig. 1: Effects of treatments on the CO_2-production of acidic sandy soil (2007-2010)

Regarding our comprehensive table (Table 3) our results showed that the examined five soil microbial parameters were positively influenced by the bentonite and zeolite treatments. At the bentonite treatments increased the total number of bacteria and nitrifying bacteria number significantly. By the effect of large dose we experienced a low-value decrease in the total number of fungi, cellulose-decomposing bacteria and soil respiration. The most stimulating treatment was the medium dose of bentonite.

The zeolite treatments also positively influenced the examined soil parameters, but at these treatments changed only the CO_2-production significantly. At the zeolite treatment from among the five examined soil microbial parameters the medium dose proved to be the most stimulating in three cases.

Regarding the total number of bacteria, the microscopic fungi, and nitrifying bacteria increased significantly in the zeolite treatments in a bigger measure, than in the bentonite treatments. The middle dose of the bentonite proved to be more effective in than zeolite concerning the cellulose-decomposing bacteria. Regarding the soil respiration we were not able to state distinction between the effects of the two natural substances.

Table 3

Comprehensive table of the examination results
(by right of the average values of the four experimental years, 2007-2010)

	Microbiological parameters	Treatments				Effects of treatment	The most effective treatment
		2	3	4	5		
Bentonite	Total number of bacteria	++	++	++	++	++	3
	Total number of fungi	++	+	-	-	+	2
	Cellulose-decomposing bacteria	++	++	+	-	+	3
	Nitrifying bacteria	++	++	++	++	++	3
	CO_2-production of soil	++	++	+	-	+	3
Zeolite	Total number of bacteria	++	++	+	+	+	3
	Total number of fungi	++	++	+	-	+	3
	Cellulose-decomposing bacteria	+	++	++	+	+	4
	Nitrifying bacteria	++	++	+	-	+	3
	CO_2-production of soil	+	++	++	++	++	4

+ increase; ++ significant increase; - decrease; -- significant decrease

CONCLUSION

All the bentonite and zeolite treatments influenced positively the soil microbiological parameters examined.

The bentonite treatments increased the total number of bacteria and the number of nitrifying bacteria significantly. The most stimulating treatment was the medium dose (equivalent 30 t ha^{-1} dose) of bentonite.

Regarding the zeolite treatments only the CO_2-production changed significantly.

In the zeolite treatments among the five examined soil microbial parameters in three (the total number of bacteria, microscopic fungi, nitrifying bacteria), the medium dose (equivalent 30 t ha^{-1} dose) proved to be the most effective.

The total number of bacteria, the microscopic fungi, and nitrifying bacteria increased in the zeolite treatments significantly in a larger scale, than in the bentonite treatments. The medium dose of bentonite proved to be more effective in case of cellulose-decomposing bacteria. Regarding the soil respiration, we were not able to state distinction between the effects of the two natural amendments.

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