THE EFFECT OF NUTRITION SUPPLY ON SOME SOIL CHEMICAL CHARACTERISTICS OF HUMUS SANDY SOIL AND SOME ELEMENTS OF THE NITROGEN-CYCLE

Kátai János , Magdolna Tállai

Department of Agrochemistry and Soil Science,
Centre of Agriculture and Engineering, Faculty of Agriculture, University of Debrecen,
katai@agr.unideb.hu

Abstract
In our pot experiment, we studied the impact of an organic fertilizer, Bactofil® A10 and an artificial fertilizer of $Ca(NO_3)_2$ content in different dosages on some soil chemical characteristics of a humus sandy soil and some soil microbiological parameters. Our test-plant was the perennial rye-grass (Lolium perenne L.). The samples were collected four and eight weeks after sowing in every year. The experiment was set up in 2007-2008 in the greenhouse of the UD CASE Department of Agrochemistry and Soil Science. In our experiment we measured the readily available nutrient content of soil, among the microbial parameters the total number of bacteria, the number of nitrifying bacteria, the nitrate-exploration, the microbial biomass nitrogen and the urease enzyme activity were measured.
Statical analysis was made means of the measurements, deviation, significance values, and correlation analysis were calculated.
The results of our experiment are summarised as follows:

- *the nitrate-nitrogen content, and the readily available phosphorus content of soil by the effect of both treatment-forms increased, in artificial fertilizer treatments in an increased measure,*
- *the Bactofil treatments had positive effect from among the measured microbial parameters primarily on the total number of bacteria,*
- *in view of nitrate-exploration and urease enzyme activity the artificial fertiliser treatments proved to be unambiguously more stimulating.*
- *We were not able to manifest a significant difference between the effect of treatment-forms in case of quantitative amount of nitrifying bacteria and microbial biomass-nitrogen content of soil.*
- *In the correlation analysis, in case of Bactofil treatments we found a tight positive correlation between the soil nitrate-N content and amount of nitrifying bacteria (r=0.883), the total number of bacteria and the microbial biomass-N content of soil (r=0.714), or rather the total number of bacteria and the urease enzyme activity (r=0.835). In case of artificial fertilizer of $Ca(NO_3)_2$ treatments we experienced tight correlation between the soil nitrate-nitrogen content and the readily available phosphorus (r=0.923) and potassium content (r=0.913), and amount of nitrifying bacteria (r=0.918). There was further tight relationship between the readily available potassium content and the amount of nitrifying bacteria (r=0.921).*

Summary we established that all the artificial fertiliser, and all the bacterium manure too advantageously changed the major soil characteristics of viewpoint of nutrient supply.
The artificial fertiliser treatments proved to be more stimulating on the score of the nutrient content of soil, from among the microbiological parameters in a larger measure influenced the nitrate-exploration and the urease enzyme activity.
Our examinations proved that Bactofil is efficiently applicable in the maintenance of the soil fertility.

Keywords: organic fertilizer, Bactofil® A10, artificial fertilizer, $Ca(NO_3)_2$, humus sandy soil, nutrient content, soil microbiology

INTRODUCTION

Nowadays in our homeland opposite the modern cultivation and an agricultural activity an increased expectation are the environmentally sound and maintainable farming, in which confine of introduction of those methods like that without the application of the chemical products - or with its reduction - preserved, repaired the soil fertility (Veres et al. 2007; Zsuposné, 2007).

Organic and green manure are among the oldest methods used for enriching the inorganic and organic colloid content of adverse condition soils and for improving their water- and nutrient management (Müller, 1991; Blaskó, 2005). Later, with intensive crop production, the application of artificial fertilizers started, which has deleterious effect (soil acidity) - primarily in case of the application of the one- sided nitrogen artificial fertilisers - which one unfavourably influences the biological activity of the soils, across the fertility of the soils and the expected quantity of yield (Lukácsné & Zsuposné, 2004).

That is why, through the avoiding these reasons from within the integrated plant production there are many opportunities, which ones we may repair the fertility of soils with natural substances. According to Lazányi, (2003) there are three categories of natural soil amelioration materials: a., the group of the green manure which can be produced on the field and other organic matters b., which get back as the byproduct of the animal husbandry into the soil, like this the livestock manure and the compost, c., mined soil conditioning substances, like alginite (Solti, 1987), bentonite (Márton & Szabóné, 2002; Makádi et al., 2003; Szeder et al., 2008) or zeolite (Köhler, 2000).

All these complement, and by today more considerable in the course of the agricultural production the application of the different bacterium preparation, particularly in the practice of the „sustainable agricultural production" (Biró, 2006). Nowadays many researcher deals with the application and impact assessment already of these different microbiological preparations, all in the field production, all in the pot experiment, between controlled relations. Hereinafter from among them we would mention some researchers:

Futó & Csorbai, (2007) examined the effect of soil bacterium product (Biorex) in 2006 in maize and sunflower culture on calcerous chernozem soil. Their experiences were, that the soil bacterium product mobilize the natural nutrient supply of the soil, the average yield of sunflower was increased with 20,4%, that of maize with 17,14%. The condition and the resistance capacity of the plants improved by usage this preparation. They established that the preparation is suggestible in the tillage cultivation for the repairing of the harmonic nutrition supply.

Makádi et al., (2007) studied the impact of biogas-digestate and Phylazonit MC® bacteria manure on the green amount of second sowing silo maize (*Zea mays L.* „Coralba") and biological activity of soil. They applied the Phylazonit MC® treatment alone, the Phylazonit MC®+biogas-digestate treatments together, and the biogas-digestate treatment alone. The field experiment was set up at the region of Nyírbátor in 2007. The test plant was soybean *(Glycine max L.)*. The Phylazonit MC®+biogas-digestate treatments together relation to the control caused significantly increasing of microbial activity. The basis of their statements the applied treatments successfully can be fitted with the sustainable agricultural practice, especially on soils witch have low humus content.

Gajdos et al. (2009) examined the effect of bacterium manuring (Phylazonit MC®) on soil polluted with cadmium in case two plants, on to the production and nutrient uptake of a sunflower (*Helianthus annus L. cv. Arena PR*) and maize (*Zea mays L. cv. Norma SC*). They had experiences that the cadmium accumulated in the root primarily. The sunflower absorbed more cadmium, and it has presumably larger stress-tolerance, than of maize. They experienced with the use of the bacterium-containing biofertilizer, the toxic effect of cadmium was moderated.

Kincses et al., (2007) studies the effect of bacterium manure on the biomass of the perennial rye-grass on two soil types. Their results – planning the achievement of an identical crop level too – stem residues and bacterium manure into soil allocation reducible the using of the quantity of artificial fertiliser, reducing the environmental loading. The effect of the bacterium manure extends over the successor season too, its effect intensifies.

Balláné et al., (2007) examined the effect of an artificial fertilizers, and a bacterium manure in lettuce culture *(Lactuca sativa L.)* on calcerous chernozem and humus sandy soil. The nitrogen artificial fertiliser significantly increased the wet and dry biomass of the plant, and advantageously influenced the nitrate and all-nitrogen content of plant. In case of the application of the bio-manure (Phylazonit MC®) was experienced that its effect was exceptionally influenced by soil characteristics. A significant change was not experienced in a performance of plant dry matter. On chernozem soil the all-nitrogen and nitrate-content increased, while a small-scale change was experienced in the measured parameters on sandy soil.

Kincses et al., (2008) their experiment examined the effects of artificial-, organic-, and bacterium manures on the 0,01 M $CaCl_2$-solube N-, P- and K content of soils, and on to the change of the acidity of the soils. Based on their results they established that the organic fertiliser is able to increase the pH of the acidic sandy soil. The combined N-getting out (artificial- and organic manure) can to provide N -, P- and K supply to the plants under the whole time of the season, while the soil become not acid. The favourable effect of the bacterium manuring can be experienced only on chernozem soil in the soil 0,01 M $CaCl_2$-soluble, for plants readily available N-, P-, K- content.

The aim of our examination was that studied the effect of a bacterium preparation, Bactofil® A10 and an artificial fertilizer containing $Ca(NO_3)_2$ in different doses on acidic humus sandy soil, on the readily available nutrient content of soil and some microbiological characteristics, specially considering of some elements of the N-cycle.

MATERIALS AND METHODS

The pot experiment was set up at the greenhouse of the UD CASE Department of Agrochemistry and Soil Science on humus sandy soil ($pH_{(H2O)}$ 5.65) in 2007-2008. The experiment was performed in three repetitions with one kg soil per pot. The moisture content of soils was set to 70% of maximum water capacity, then they were irrigated daily to a constant mass. As a test plant, perennial ryegrass *(Lolium perenne L.)* was used. Samples were collected in fourth and eight weeks of the season. After through homogenization, the laboratory examinations were performed at the soil chemistry and soil microbiology lab of the Department. As a basic treatment, 100 mg P_2O_5 and 100 mg K_2O was applied to each pot as a common solution of potassiumdihydrogen-
phosphate and potassium-sulphate were applied. The nitrogen was added into the soil in form $Ca(NO_3)_2$ solution.

We made three treatments in the year of 2007, while in the 2008 year complementing growing dosages were given out. The different treatments are presented in *Table 1.*

Table 1

In the experiment applied Bactofil and $Ca(NO_3)_2$ treatments and dosages

Soil type	Treatments number	Ttreatments and dosages	
		2007.	**2008.**
Humus sandy soli	**1.**	Controll	Controll
	2.	* Bactofil® A10	* Bactofil® A10
	3.	-	** Bactofil® A10
	4.	100 mg kg^{-1} N [$Ca(NO_3)_2$]	100 mg kg^{-1} N [$Ca(NO_3)_2$]
	5.	-	200 mg kg^{-1} N [$Ca(NO_3)_2$]
*	*2.5 times the field dosage (10,75*10^5bacteria kg^{-1})*		
**	*5 times the field dosage (21,50*10^5bacteria kg^{-1})*		

We measured the nitrate-N content, and the degree of nitrate-exploration after 14 days incubation (Felföldy, 1987), further the readily available phosphorus and potassium content (Gerei, 1970). From among the microbial parameters, the total number of bacteria was determined by plate dilution from soil-water suspension (on Bouillon soup agar) (Szegi, 1979), the number of nitrifying bacteria was determined by most probable number of germs method of Pochon & Tardieux, (1962). We also measured the microbial biomass-N content of soil (Jenkinson & Powlson, 1976), and the urease enzyme activity (Kempers cit. Filep., 1995).

The results were evaluated statistically, the means of samplings, deviation and significant differences were calculated and correlation analysis was applied for revealing the relationships between the studied parameters. Statistical evaluation was done using the SPSS 13.0 programme.

RESULTS

The effect of the treatments on the examined soil characteristics in case of the common treatments is presented by right of the average values results of the two examination years (2007-2008), and the tables, figures include the averages of the repetitions at the two sampling dates in 2008 year.

The readily available nutrient content of soil showed growing due to the treatments in case of all examined parameter. The nitrate-nitrogen content of soil (*Figure 1.*) significantly increased we measured the largest value in the last treatment.

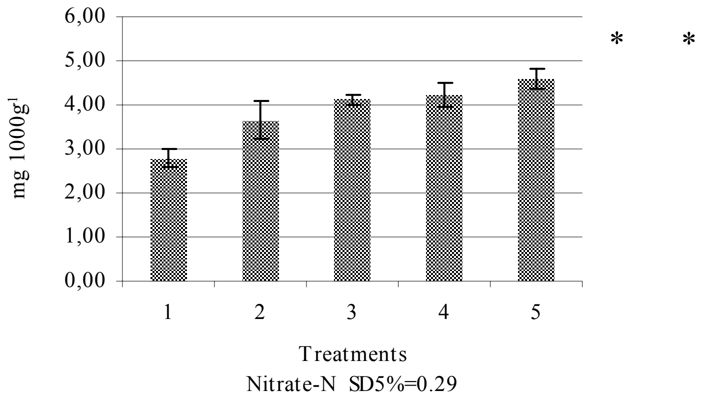

Fig. 1: The effect of nutrient supplying forms on the nitrate-nitrogen content of soil (2007-2008)

Regarding the readily available phosphorus and potassium content *(Figure 2.)* the soil was in the medium-(84.75 P_2O_5 mg 1000^{-1}), and well-supplied categories (229.60 K_2O mg 1000^{-1}). The readily available phosphorus content of the soil varied between 84.75 and 105.00 mg kg^{-1}, their quantity increased significantly only by artificial treatments, while the value of AL-soluble potassium was between 229.60 and 243.30 mg $1000g^{-1}$, in case of the potassium the treatments did not have a significant effect.

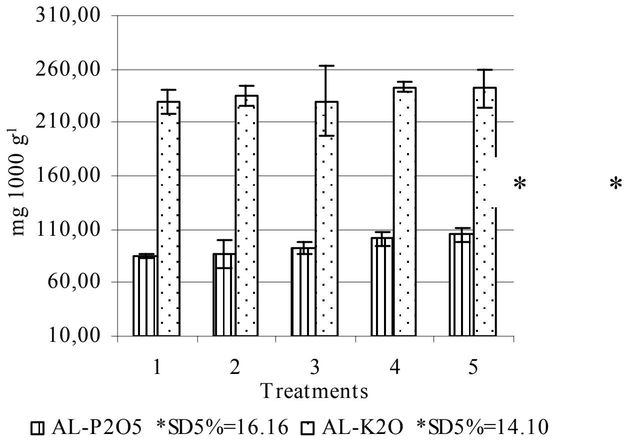

Fig. 2.: The effect of nutrient supplying forms on the readily available phosphorus and potassium content of soil (2007-2008)

Among the soil microbial parameters *(Table 2.)*, the total number of bacteria was measured in both treatment types. The highest dosage of the two treatments increased significantly their number, we determined the higher value in Bactofil treatment.

The number of nitrifying bacteria also increased in all treatments significantly, their number was the largest in the artificial fertiliser treatment with a higher dosage. There was however no significant difference between the two nutrient supplying forms.

The nitrate-exploration was growing likewise, significantly on the effect of a smaller dosage Bactofil treatment, and the artificial fertiliser treatments. By artificial fertiliser treatments already the smaller dosage caused a significant increasing. A significant difference appeared in the effect of the two treatments, the artificial fertiliser dosages proved to be more stimulating.

There is no significant change in the soil microbial biomass-N content, in the impact of treatments we were not able to confirm any kind of different.

We determined finally the urease enzyme activity. Higher – significant - activity values caused the artificial fertiliser treatments, the enzyme activity was the most intensive in the case of the lower dosage.

Table 2

The effect of nutrient supplying forms on some soil microbial parameter (2007-2008)

Treatments number	**Total number of bacteria (*10^6 g^{-1} soil)**	**Nitrifying bacteria (*10^3 g^{-1} soil**	**Nitrate-exploration (mg $1000g^{-1}$)**	**Biomass-N (µg g^{-1} talaj)**	**Urease enzyme (NH_4-N mg $100g^{-1}24h^{-1}$)**
1.	5.10	2.33	4.24	18.40	46.90
2.	5.66	*4.52	*4.91	20.65	45.30
3.	*6.00	*4.88	4.37	19.32	49.00
4.	5.55	*4.21	*5.95	20.39	*82.00
5.	*5.97	*5.40	*5.56	21.73	*53.30
***$SD_{5\%}$**	0.76	1.20	0.60	5.72	5.80

The results were evaluated by correlation analysis to determine the relationship between the changes in the soil nutrient content and the studied microbial parameters separately for the Bactofil and $Ca(NO_3)_2$ artificial fertilizer treatments *(Table 3).*

In the Bactofil treatments a medium positive correlation was found between the nitrate-N content and the readily available potassium content (r=0.673), between the readily available phosphorus content and the number of nitrifying bacteria (r=0.591) and the value of nitrate-exploration (r=0.663). There was also a medium positive correlation between the readily available potassium content and the amount of nitrifying bacteria (r=0.557), additionally between the amount of nitrifying bacteria and nitrate-exploration of soil (r=0.515).

There was a tight positive correlation between the soil nitrate-N content and the amount of nitrifying bacteria (r=0.883), between the total number of bacteria and the microbial biomass-N content of soil (r=0.714), or rather between the total number of bacteria and the urease enzyme activity (r=0.835).

In case of the $Ca(NO_3)_2$ artificial fertilizer treatments medium positive correlation supposed to discover between the nitrate-nitrogen content and the soil nitrate-exploration (r=0.649), the readily available phosphorus content and the value of nitrate-exploration (r=0.694), the nitrate-exploration and the readily available potassium content (r=0.529), the number of nitrifying bacteria and the nitrate-exploration (r=0.609), finally the nitrifying bacteria and the urease enzym activity (r=0.546).

We established a tight relationship between the nitrate-nitrogen content and the AL-solube phosphorus (r=0.923) and potassium (r=0.913) content of soil and the number of nitrifying bacteria (r=0.918). Furthermore there was also a tight relation between the AL-solube potassium content and the amount of nitrifying bacteria (r=0.921).

Table 3

Relation between the examined soil chemical and microbiological characteristics (Pearson Correlations 2007-2008.)

	Bactofil treatments							
Examined soil parameters	Nitrate-N	AL-P_2O_5	AL-K_2O	Total number of bacteria	Nitrifying bacteria	Nitrate-exploration	Biomass -N	Urease enzyme
Nitrate-N	1							
AL-P_2O_5	.411	1						
AL-K_2O	.673(**)	.372	1					
Total No. of bacteria	.168	.339	.259	1				
Nitrifying bacteria	.883(**)	.591(**)	.557(*)	.272	1			
Nitrate-exploration	.470	.663(**)	.239	.196	.515(*)	1		
Biomass-N	.231	.339	.225	.714(**)	.371	.070	1	
Urease enzyme	.161	.423	.207	.835(**)	.351	.215	.473	1
	$Ca(NO_3)_2$ artificial fertilizer treatments							
Nitrate-N	1							
AL-P_2O_5	.923(**)	1						
AL-K_2O	.913(**)	.449	1					
Total No. of bacteria	.279	.353	.416	1				
Nitrifying bacteria	.918(**)	.447	.921(**)	.279	1			
Nitrate-exploration	.649(**)	.694(**)	.529(*)	.181	.609(**)	1		
Biomass-N	.429	.408	.441	.380	.426	.436	1	
Urease enzyme	.457	.458	.477	.437	.546(*)	.222	.162	1
** Correlation is significant at the 0.01 level								
* Correlation is significant at the 0.05 level								

CONCLUSIONS

The nitrate-nitrogen content and the readily available phosphorus content of soil by the effect of both treatment-forms increased, in artificial fertilizer treatments in an increased measure.

The Bactofil treatments had positive effect from among the measured microbial parameters primarily on the total number of bacteria.

We were not able to manifest a significant difference between the effect of treatment-forms in case of quantitative amount of nitrifying bacteria and microbial biomass-nitrogen content of soil.

In view of nitrate-exploration and urease enzyme activity the artificial fertiliser treatments proved to be unambiguously more stimulating.

In the correlation analysis we found some medium and tight positive correlation between the examined soil chemical and microbiological parameters in case of both treatment-forms.

All the artificial fertilizer and all the bacterium manure too advantageously changed the major soil characteristics of viewpoint of nutrient supply.

The artificial fertiliser treatments proved to be more stimulating in case of the nutrient content of soil, among the microbiological parameters in a larger measure squarely influenced the nitrate-exploration and the urease enzyme activity.

Our examinations proved that Bactofil is efficiently applicable in the maintenance of the soil fertility.

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