THE EFFECT OF ALTERNATIVE METHODS OF NUTRIENT SUPPLY ON SOME MICROBIOLOGICAL CHARACTERISTICS OF A CHERNOZEM SOIL

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Abstract

Nowadays the alternative fertilization opportunities have become widely available. They can reduce the amount of fertilizers applied. In the last few years the application of different microbial products customary spread for agricultural cultivation. With the microbial preparations different bacterial strains are allocated into the soil that increase the microbial activity of soils and help the modification of nutrient uptake. A pot experiment was set up in the greenhouse of the Institute of Agricultural Chemistry and Soil Science using a calcareous chernozem soil. The testplant was perennial ryegrass (Lolium perenne L.). In laboratory the effect of artificial, bacterium and straw fertilization were measured on some microbiological parameters and enzyme activity of soil.

Key words: biofertilizers, microbiology, enzyme activity, chernozem soil.

INTRODUCTION

The microbiological organisms play a very important role in the productivity of soils (Szili-Kovács & Takács, 2008). The positive effect of fertilization on soil microorganisms were established by the study of Helmeczi, (1983), Kátai, (1999) and Tállai et al., (2008).

In Hungary the use of microbiological preparations has spred in agriculture since 1960 (Manninger & Szegi, 1963). The first generation preparations contained one bacterial strain (Rhizobium, Azotobacter), which was studied compared to the effect of fertilizers. Nowadays the preparations contain a lot of microorganisms, this „new generation preparations" were applied, wich contain nitrifying, cellulose decomposing and solubising microorganisms (Biró, 2003).

In previous studies the effects of different preparations on soil and plant properties have been established. Positive effects were shown in fertilizer-preparation combinations by Kumar et al., (1999), Makádi et al., (2007), Leaungvutiviroj et al., (2010), Dadnia et al., (2010), Afzal et al., (2010), Balla Kovács – Jakab (2010), Jakab et al., (2011), but there were negative results as well (Misra and Naidu (1990), Schweinsberg-Mickan and Müller (2009)).

We investigated in a pot experiment the effect of different biofertilizers that are available in commerce, together with the use of fertilizers and straw.

We examined the effects of combinations on the microbial and enzyme activity of soil.

MATERIALS AND METHODS

The pot experiment was set up in the greenhouse of the Institute of Agrochemistry and Soil Science in 2010. The test plant was ryegrass (*Lolium perenne*, L). The soil was a loamy calcareorus chernozem soil. The physical and chemical properties determined were the following: KA: 37,5; Silt and clay fraction: 51%; $pH_{(KCl)}$: 5,5; $pH_{(H2O)}$: 6,6; Hu%: 2,8; AL-P_2O_5: 140 $mg*kg^{-1}$; AL-K_2O: 316 $mg*kg^{-1}$.

We applied control treatment, NPK fertilizer and straw treatments in different combinations with three biofertilizers (Bactofil A, EM-1, Microbion UNC). The applied treatments are illustrated in Table 1. In manuring was dole out nitrogen as NH_4NO_3, phosphorus as KH_2PO_4, potassium as KH_2PO_4 and K_2SO_4. In the straw treatment 7 t ha^{-1} straw pot^{-1} were stirred in. The applied quantity of biofertilizers was the double of the recommended dosis of field application.

In the perforated pots 1-1 kg air-dried soil was measured and in soil surface 0,6-0,6 g perennial seed was sown. Weight supplement irrigation of the vessels was performed every day for 60% of field water capacity. The soil samples were collected after eight weeks.

For determining the number of soil microorganisms, the total number of bacteria (on Bouillon soup agar) and the total number of microscopic fungi (on peptone glucose agar) was determined from soil-water suspension by the plate dilution method based on Szegi (1979), while the number of cellulose decomposing and nitrifying bacteria was determined following to Pochon (1962).

We measured the enzyme activities of soil. The urease enzyme activity was determined based on Szegi (1979). The saccharase enzyme activity was measured following to Frankenberger & Johanson (1983). The dehidrogenase enzyme activity was performed by the method of Mersi (1991), the quantity of formed INTF (iodine nitrotetrazolium formasane) was measured using photometry.

For the examination of the statistically justifiable differences between the average values of the results we applied Tolner et al. (2008) one-factor analysis of variance on statistical data, which showed 5% significant difference values.

RESULTS AND DISCUSSION

The microbiological parameters of soils are illustrated in Table 1.

Table 1

The microbiological properties of soil.

Treatments	Total number of bacteria (*10^6 g^{-1} soil)	Cellulose decomposing bacteria (*10^3 g^{-1} soil)	Nitrifying bacteria (*10^3 g^{-1} soil)	Total number of fungi (*10^3 g^{-1} soil)
Control	17,88	6,22	1,96	22,33
NPK	26,27	5,41	0,91	42,00
Straw	11,70	7,37	0,52	35,00
Control+BA*	14,52	185,33	0,78	31,33
NPK+BA	17,52	8,29	1,61	43,33
Straw+BA	13,12	105,90	0,78	37,33
Control+EM*	13,67	105,90	1,07	32,33
NPK+EM	16,82	32,23	2,99	37,33
Straw+EM	8,06	185,32	1,61	17,33
Control+MI*	11,91	105,90	1,06	20,33
NPK+MI	13,30	7,94	2,99	37,67
Straw+MI	7,24	185,32	1,06	27,33
Mean	*14,33*	*78,43*	*1,45*	*31,97*
$LSD_{5\%}$	***0,37***	***3,62***	***0,04***	***1,51***

* BA: Bactofil A, EM: EM-1, MI: Microbion UNC biofertilizers

The total number of germs increased due to manuring (NPK), which was probably a consequence of improved nutrition. The straw treatment impacted the number of bacteria negatively. The biofertilizers decreased the number of cells significantly. The combination of NPK+biofertilizer compared to the manuring, as well as the combination of straw+biofertilizer compared to straw treatment decreased the colony of bacteria significantly, except for the straw+Bactofil A combination.

The amount of aerob cellulose decomposing bacteria was increased by the biofertilization compared to the control. The NPK+EM-1 combination influenced the number of cells positively. The straw+biofertilizer combinations compared to straw treatment caused significant increase that may be result of the presence of favorable conditions.

The number of nitrifying bacteria was decreased by the manuring. The nitrogen content of the fertilizer decreased the amount of nitrifying bacteria, and increased, that of the cellulose decomposing bacteria. The straw treatment reduced the cells significantly. The biofertilization caused significant decrease compared to the control. The NPK+biofertilizer combinations stimulated the number of nitrifying cells. The straw+biofertilizer combinations compared to straw treatments increased the amount of nitrifying bacteria.

The manuring and straw treatments influenced the number of microscopic fungi positively. The Bactofil A biofertilizer was as effective as the NPK and straw. The amount of fungus colonies was increased by NPK+biofertilizer combinations. The straw+Bactofil A combination caused a significant increase compared to the straw treatment.

The means of enzyme activity of soils are illustrated in *Table 2*.

Table 2

The enzyme activity of soil.

Treatment	**Urease enzyme NH_4^+ (mg 100g^{-1})**	**Saccharase enzyme glucose (mg 100g^{-1})**	**Dehidrogenase enzyme INTF (µg g^{-1})**
Control	25,6	15,4	529,7
NPK	169,5	21,3	505,6
Straw	24,4	14,3	585,1
Control+BA*	23,1	10,9	552,0
NPK+BA	2,7	13,8	410,3
Straw+BA	174,4	15,0	446,8
Control+EM*	9,7	14,3	477,8
NPK+EM	166,6	15,8	687,9
Straw+EM	1,4	13,6	498,4
Control+MI*	34,5	12,0	464,6
NPK+MI	94,7	15,3	451,6
Straw+MI	51,9	13,8	389,8
Mean	*64,9*	*14,6*	*500,0*
$LSD_{5\%}$	***10,5***	***0,8***	***7,2***

* BA: Bactofil A, EM: EM-1, MI: Microbion UNC biofertilizers

The NPK fertilization increased the urease enzyme activity significantly, while the EM-1 biofertilizer caused a decline in the activity. The NPK+EM-1 combination stimulated the activity in a similar way to the straw+Bactofil A and straw+Microbion UNC combinations.

The saccharase enzyme activity was increased by manuring, while the straw and biofertilizer treatments caused significant decrease. The NPK+biofertilizer combinations caused a decline in the activity values compared to manuring. The straw+biofertilizer combinations had similar effects to that of straw treatments.

The dehidrogenase enzyme activity was influenced negatively by the NPK manuring, while the straw treatment caused an increase. The Bactofil A fertilizing compared to the control resulted in activity growth. The NPK+EM-1 combination increased the enzyme activity compared to the manuring, while the straw+biofertilizer combinations caused a decline in the values of activity.

CONCLUSION

We established that the application of biofertilizers increased some microbial parameters and the enzyme activity of soil.

- The total number of bacteria increased during NPK fertilization. The biofertilization and the straw+biofertilizer combinations stimulated the number of aerob cellulose decomposing bacteria. The NPK ferilizer+biofertilizer and straw+biofertilizer combinations influenced the number of nitrifying bacteria positively. The number of microscopic fungi grew in most treatments significantly, except for the Microbion UNC biofertilization.
- A lot of treatments increased the urease enzyme activity of soil, for example the NPK, NPK+EM-1, straw+Bactofil A and straw+Microbion UNC combinations. The manuring increased the saccharase enzyme activity of soil. The straw, Bactofil A ferilization and NPK+EM-1 combination increased the dehidrogenase enzyme activity of soil.

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