EFFECT OF BACTERIAL PREPARATIONS ON THE RYEGRASS (*LOLIUM PERENNE*, L.) BIOMASS OF CALCAREOUS CHERNOZEM SOIL

Jakab Anita, Magdolna Tállai, János Kátai

Institute of Agrochemistry and Soil Science, Centre for Agricultural Sciences and Engineering, Faculty of Agriculture University of Debrecen,
jakaba@agr.unideb.hub

Abstract

We studied in a pot experiment the effect of bacterial preparations on the biomass, potassium and phosphorus content of ryegrass (Lolium perenne, L). The experiment was set up in 2010 at the Department of Soil Science and Agricultural Chemistry, in three replications in a random block. The ryegrass (Lolium perenne, L.) was used as a test plant. The studied soil type was calcareous chernosem soil from Látókép.

The results of the study were the following:

-The NPK fertilizer and bacterial preparation treatments increased the plant green production.

-The NPK fertilizer – bacterial preparation combinations increased significantly the green production.

-The NPK – bacterial fertilizer combinations influenced positively the educed phosphorus and potassium by plant like the green production.

-The combination of fertilizer- bacterial preparations influenced significantly the educed potassium by ryegrass.

Keywords: bacterial preparations, calcareous chernozem soil, plant biomass, potassium and phosphorus content of ryegrass

INTRODUCTION

The soil is an important natural resource. Suitable soil usage helps its renewal (Várallyay, 2001). Intensive agricultural activity of the latter decades effected the decay of the state of our soils. This appeared not only in the features of the soils, but in the crops quantitative and qualitative characteristics. The unilaterally application of nitrogen fertilizer containing yielded many problems the appearance and intensification (Pusztai, 1978).

The macro nutrients play important role in the vital processes of plants like metabolism, growth and healthy development. The phosphorus and potassium are indispensable nutrient elements which reach in the crops the percentage rate (Debreczeni and Sárdi, 1999; Pethő, 1993).

The plants take up the phosphorus in the form of $H_2PO_4^-$ and HPO_4^{2-} ions, which influence the acidity. The plants take up in the soils with acidic acidity $H_2PO_4^-$ ions, but in alkaline acidity add the form of HPO_4^{2-} ions. Our soils phosphorus content change among 0.02 - 0.10%. The phosphorus

appears in organic and inorganic forms. The proportions of these are approximately 50-50 percentages (Loch and Nosticzius, 2004).
The plants take up potassium in the form of ions. The nutrient uptake is possible in the soil soluble and on the soil colloids adsorbed forms. The potassium reserve in soils is the fixed and the adsorbed forms in the clay-mineral crystals (Stefanovics et al., 1999). The total potassium content in soils change among 0.2 - 3.3%. The total potassium content in sodic soils may be up to 6% (Loch and Nosticzius, 2004).
The potassium reserve in hard ground soils is with an order of magnitude bigger, than the phosphorus reserve. This reserve is available to the plants for several years (Kádár, 1980).
Nowadays, the sustainable cultivation is coming into the foreground feature. Consequently, the reducing of the quantity of fertilizers and the choice of the correct composition are the important objectives. The soils qualitative repairing activities are increasing. These activities are the different microbial preparations, which use in the agricultural production (Biró, 2003).
The fertilizers can reduce the usage of bacterial (Solti, 2004). But on their effects are little available scientific data. Last years studied the effects of microbial preparations on the soil physical, chemical and microbiological properties and on the test plant quantitative and qualitative characteristics in pot experiments.
In the experiments were effective the bacterial fertilizers at Balla (2010), Kincses et al. (2008), Tállai (2010, Tállai et al. (2008), Katai et al. (2008), but they were not effective treatments at Balláné et al. (2008).
In the present paper the changes of ryegrass (*Lolium perenne*, L.) biomass, phosphorus and potassium content of ryegrass, and the changes of the AL-soluble phosphorus and potassium content of soils are presented on the basis of a pot experiment where bacterial fertilizers were used.

MATERIALS AND METHODS

The pot experiment was set up at the Department of Agrochemistry and Soil Science, University of Debrecen in May 2010 on calcareous chernozem soil. The main features of the soil are illustrated in *Table 1*. Ryegrass (*Lolium perenne,* L.) was used as a test plant. Every pot had 1 kg of AD soil. In each dish 0.6 g ryegrass seeds were sown.

The treatments applied in the experiment are illustrated in *Table* 2. In the treatments 20 cm^{-3} of NPK artificial fertilizer (0,2857 g 20 cm^{-3} NH_4NO_3, 0,1915 g 20 cm^{-3} KH_2PO_4; 0,0625 g 20 cm^{-3} K_2SO_4), 3g of straw, Bactofil A (20 cm^{-3}), EM-1 (15 cm^{-3}) and Microbion UNC (0,01 g) bacterial preparations were used. Weight supplement irrigation of the vessels was

performed every day for 60% of field water capacity. The soil and plant samples were collected after eight weeks.

Table 1

Important parameters of soil applied in the pot experiment

Soil properties	**Calcareous chernozem soil**
Humus%	1,65
K_A: plasticity index according to Arany	37,5
pH_{KCl}	5,50
pH_{h2O}	6,60
AL- soluble P_2O_5 (mg kg^{-1})	140
AL-soluble K_2O (mg kg^{-1})	316,25
Li%(Clay and silt content)	51,36

In the experiment the phosphorus and potassium content of ryegrass, and the green weight of ryegrass were determined according to Loch, et al. (1982), the definition of the AL-soluble P_2O_5 and K_2O content of the soil was carried out on the basis of Gerei (1970).

Table 2.

The experimental treatments

Treatment	Basic treatment	Bacterial fertilizers
1	Kontroll (0)	0
2	NPK*	0
3	Straw	0
4	0	Bactofil A
5	NPK	Bactofil A
6	Straw	Bactofil A
7	0	EM-1
8	NPK	EM-1
9	Straw	EM-1
10	0	Microbion UNC
11	NPK	Microbion UNC
12	Straw	Microbion UNC
*NPK: $N=NH_4NO_3$, $P=KH_2PO_4$, $K=K_2SO_4 + KH_2PO_4$.		

The Bactofil A bacterial fertilizer applied is an aqueous suspension with pH 5 – 6.5, the total number of bacteria is at least $4.3*10^9$ cell cm^{-3}. In addition to microbes it contains macro and micro nutrients, and enzymes synthesized by microorganisms. The total number of bacteria of the EM-1 bacterial manure is 5 billion cm^{-3}. It contains more than 80 strains (aerobic, anaerobic bacteria, micro- and ray fungi). Microbion UNC is a solid bacterial fertilizer, with pH 5.5. The total number of bacteria in this manure is $4*10^{10}$ piece g^{-1}. It contains microorganisms, synthesized agents and vitamins, GM-8 corn cob meal and dried beer yeast.

The experiment was set up in three replications in a random block. For the examination of the statistically justifiable differences between the

average values of the results we applied Microsoft Office Excel two-factor analysis of variance on statistical data.

RESULTS AND DISCUSSION

The values of the biomass of ryegrass are illustrated in *Table 3*.

Table 3

The biomass of ryegrass and the LSD5% values of experiment

	Without bacterial fertilizer	Bactofil A	EM-1	Microbion UNC
Green production of ryegrass (g pot^{-1})				
Control	6.22	5.81	5.55	6.30
NPK fertilizer	19.04	19.99	18.62	20.72
Straw	4.58	4.50	4.42	4.65
$LSD_{5\%}$	*3.06*		*3.63*	*2.65*
Soluble phosphorus by the ryegrass (mg pot^{-1})				
Control	18.11	16.24	15.15	19.09
NPK fertilizer	50.07	51.41	61.59	56.74
Straw	13.65	14.40	13.10	14.38
$LSD_{5\%}$	*7.06*		*7.89*	*6.37*
Soluble potassium by the ryegrass (g pot^{-1})				
Control	0.277	0.239	0.271	0.292
NPK fertilizer	1.110	1.210	1.022	1.414
Straw	0.179	0.211	0.175	0.226
$LSD_{5\%}$	*0.209*		*0.215*	*0.139*

The average values of the *ryegrass green production* changed between 4.42 – 20.72 g pot^{-1}.We established that the NPK fertilizer treatment was significantly increasing compared to the control. However, the straw treatment was not significantly effective, but we detected some production increasing. The effect was the result of N immobilization. The bacterial preparations used exclusively by the Microbion UNC bacterial fertilizer increasing, but not significantly. At the NPK – bacterial fertilizer combinations were effective the preparations. At the straw – bacterial fertilizer combinations effected decreasing compared to the control. The most effective treatment was the NPK - Microbion UNC treatment. There was the ryegrass green production 20.72 g pot^{-1}.

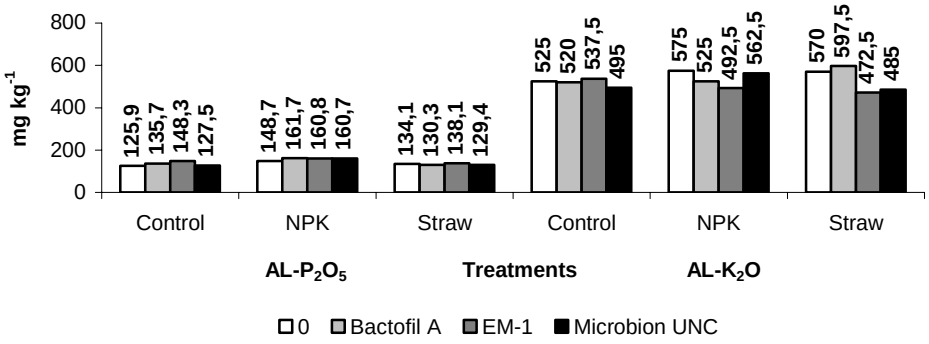

Figure 1: The AL-soluble phosphorus and potassium content of soil

Table 4

The LSD5% values of the AL-soluble phosphorus and potassium content of soil

	Bactofil A	EM-1	Microbion UNC
$LSD_{5\%\ AL\text{-}P2O5}$	11.81	17.53	9.45
$LSD_{5\%\ AL\text{-}K2O}$	54.77	43.10	47.13

The *soluble phosphorus values by the ryegrass* are illustrated in *Table 3*. The values changed between 13.10 – 61.59 mg pot^{-1}. The average values of NPK fertilizer compared to the control was significantly increased. The AL-soluble phosphorus content of soil similarly formed (Figure 1.). The improving nutrient state increased the reconding of plant. The straw treatment decreased the values, but not significantly. The bacterial fertilizers did not result changes. The NPK – bacterial fertilizer treatments were significantly increasing at the NPK – EM-1 and NPK – Microbion UNC treatments. The AL-soluble phosphorus content of soil was at these treatments increased. The nutrient supply and the microbial treatments together were more effective. The straw – bacterial fertilizer treatments like the basic treatments were not effective. The most effective treatment was the NPK - EM-1 combination (61.59 mg pot^{-1}).

The *soluble potassium values by the ryegrass* are illustrated in *Table 3*. The values were changed between 0.175 – 1.414 g pot^{-1}. The NPK fertilizer compared to the control increased significantly changes. In some cases agreed the treatments effect at the soluble potassium values by the ryegrass and, at the AL-soluble potassium content of soil (*Figure 1.*). The straw treatment was not effective. The positive effect of bacterial fertilizers was at the EM-1 treatment, but not significantly. The NPK – bacterial fertilizer combinations compared to the NPK treatments were increasing. At these treatments increased significantly the AL-soluble nutrient content of soil. Together, these changes have resulted in the samples. The straw – bacterial fertilizers compared to the straw treatment increased the values except the

straw – EM-1 treatment. The bacterial fertilizers probably helped the mineralization of straw and the recording of potassium.

CONCLUSION

from our results we established that the NPK fertilization compared to the controll resulted significantly increasing at the examined samples. The improvement of nutrient supply increased the ryegrass green production and the soluble elements volumes. The straw treatment decreased the ryegrass biomass, this effect was due to the N immobilization. The bacterial preparations were not effective itself, but with NPK fertilizer increased the ryegrass green production and nutrient record. The ryegrass biomass increased at the microbial preparation treatments, but with NPK fertilizers the effects were more effective. The fertilizer with microbial products resulted improvement in the values. The soluble phosphorus and potassium values by ryegrass increased at the NPK – bacterial fertilizer treatments. The plant nutrient uptake followed the AL-soluble phosphorus and potassium content of soil, they showed similar dinamics.

That we understand the effects of bacterial fertilizers we needed perform more tests.

REFERENCES

1. Balla K.A., (2010): Studies of the effects of N fertilizers and Microbion UNC biofertilizer on microelement content of horseradish (Armoracia macrocarpa). Acta Agraria Debreceniensis. 38. 41-46.
2. Balláné K. A. – Kremper R. – Vágó I. – Filep T. (2008): Az NH4NO3 és a Phylazonit MC baktériumtrágya hatása a talaj könnyen oldható nitrogén, foszfor- és káliumtartalmára. Talajvédelem különszám (szerk.: Simon L.) 361-368.
3. Biró B. (2003): A növény – talaj – mikroba kölcsönhatások szerepe az elemfelvétel alakulásában. p.1-11. In: Mikroelemek a táplálékláncban. (szerk. Simon L, Szilágyi M), Bessenyei Gy. Könyvkiadó, Nyíregyháza, ISBN 963 9385 81 6
4. Debreczeni B.né – Sárdi K. (1999): Tápanyag-gazdálkodás. Szerk.: Füleky Gy. Mezőgazda Kiadó. Budapest. 30-91.
5. Füleky Gy: - Rajkainé V. K. (1999): Tápanyag-gazdálkodás. Szerk: Füleky Gy. Mezőgazda Kiadó. Budapest. 91-130.
6. Gerei L.(szerk.) (1970): Talajtani és agrokémiai vizsgálati módszerek. OMMI kiadvány. 17-19.
7. Kádár I. (1980): A kálium jelentősége földművelésünkben és egy csernozjom talaj termékenységében. Agrokémia és Talajtan 29. 577-590.
8. Katai, J. – Sandor, Z. – Tallai, M., (2008): The effect of an artificial and a bacterium fertilizer on some soil characteristics and on the biomass of the rye-grass (Lolium perenne L.). Cereal Research Communications, 36. 1171-1174. p. part.2 Suppl.S.

9. Kincses S.I. – Nagy P.T. – Kremper R. (2008): Baktériumtrágyák hatása az angolperje (Lolium perenne L.) termésére különböző típusú talajon. Tudományos Konferencia Kiadvány, Kecskemét. ISSN:1586-846x 92-97..
10. Loch J. – Nosticzius Á. (2004): Agrokémia és növényvédelmi kémia. Mezőgazda Kiadó. Budapest. 19-115.
11. Pethő M. (1993): Mezőgazdasági növények élettana. Akadémiai Kiad. Budapest.
12. Pusztai A. (1978): Intenzív műtrágyázás és a környezetszennyezés. Agrokémia és Talajtan. Tom. 27. No. 1-2. 219-227.
13. Stefanovics P. – Filep Gy. & Füleky Gy. (1999): Talajtan. Mezőgazdasági Kiadó. Budapest.
14. Solti G. (2004): Talajoltó baktériumtrágyák. Magyar Mezőgazdaság. 2004. 59. 39. 19.
15. Tahmm F.-né – Krámer M. – Sarkadi J. (1968): Növények és trágya-anyagok foszfortartalmának meghatározása ammonium-molibdovanadátos módszerrel. Agrokémia és Talajtan. 17. 145-156 p.
16. Tállai, M. (2010): Comparative examination of a bacterium preparation (BACTOFIL A10) and an artificial fertilizer (Ca(NO3)2) on calcareous chernozem soil. Journal of Agricultural Sciences, Debrecen 2010 Vol. 38. 75-80. p.
17. Tállai M. – Sándor ZS. – Vágó I. – Kátai J. (2008): A tápanyagutánpótlás különböző módjainak hatása a talaj néhány mikrobiológiai tulajdonságára. Agrártudományi közlemények 2008. Vol 32. 119-126.
18. Várallyay Gy. (2001): Szemléletváltozások a magyarországi talajjavítás történetében. Agrokémia és Talajtan. 50. 119-135.