# Investigation of after-effect of bacterium fertilization in pot experiment

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***SUMMARY***

*Ecological farming is getting even more wide spread, in horticulture as well, within that – beside fertilizers – the organic manure and bacteria fertilizers are becoming more and more important.*
*In our comparing experiment we studied the effect of mineral fertilizer and bacteria fertilizer on the dry matter production and nitrogen-content of parsley (Petroselium crispum) and on the 0,01 M $CaCl_2$-soluble N-content – that is easily taken up by plants – of two different soil types. In the second year of our experiment we used only mineral fertilizer, so that we could reveal the after effect of bacteria fertilizer (Philazonit-MC).*
*The results of our experiment are the following:*

- *On the chernozem soil the N-fertilizer significantly increased the dry matter production of parsley. On the other hand the bacteria fertilization on the same soil type in the first vegetation period only trended to, contrarily in the second vegetation period significantly increased the dry matter of parsley.*
- *On the sandy soil – in both years – the N-fertilization trended to increase the dry matter production of plants, but bacteria fertilization – also in both vegetation periods – with higher amount of nitrogen added resulted a dry matter yield increment, while with a lower amount of nitrogen added it decreased the dry matter production of plants. The effect is not proven by statistical analysis.*
- *A positive significant effect was detected on the chernozem soil between N-fertilization and the N-content of plants. Bacteria fertilization contrarily did not have any influence on it.*
- *On the sandy soil N-fertilization resulted a N-content increment in both vegetation periods. The positive effect of bacteria fertilization could be revealed in the second year.*
- *N-fertilization increased the 0,01 M $CaCl_2$-soluble N-content of chernozem soil in both years. This effect is also statistically proven. Bacteria-fertilization, however in the first year significantly increased, in the second year trended to decrease the 0,01 M $CaCl_2$-soluble N-concentration of the chernozem soil.*
- *We could reveal a positive significant effect between the 0,01 M $CaCl_2$-soluble N-content of the sandy soil and the N-fertilization in both vegetation periods. Bacteria-fertilization showed a trend to decrease this content.*
  *To draw further conclusions other examinations are needed in the future.*

## *INTRODUCTION*

The good quality and sufficient quantity of the yield is the main aim in horticulture and is primarily determined by the genetic potential of plants, by ecological parameters and plant nutrition. Plant-nutrition is an important production factor to reach the genetic potential maximum of yield. In the past decades the nutrients extracted by the yield were refilled – besides manure – first of all by chemical fertilizers. The inefficient use and overdoses of these fertilizers may cause damages in the environment (Loch és Nosticzius, 1992). Using too high amount of fertilizers can result a higher level of soil (Chander és Abrol, 1972; Felizardo et al., 1972; Nagy P.T, 2003; Nagy et al. 2007). Soil pH affects plant life in a direct and in an indirect way, as well. It has a direct effect on the solubility and uptake of nutrients. An influence on the soil microorganisms and a modification of the mobilization of nutrients can be mentioned as indirect effect, for we know that different microorganisms react in a different way to the change of soil pH.

In Hungary it has become important to use environment friendly farming methods. These methods preserve or even grade soil fertility up without – or with a lower amount of – chemical products used (Veres et al. 2007; Shen 1997; Zsuposné 2007). These farming methods focus primarily on the enhancement of the native soil microbial activity. Therefore special bacteria fertilizers are becoming even more wide spread and used (Makádi et al. 2007). By adding bacteria fertilizers we can make the soil microbial population more complex and rich while we add – from the aspect of plant nutrition – favourable bacteria species to the soil. The effect of bacteria fertilization on the – for plants available – nutrient content of soils and therefore on the quality and quantity of the yield may last over more vegetation periods. In our experiment and in this paper we studied also this phenomenon. We suppose, that our results can be used for the elaboration of an environmental friendly, site-specific fertilization, that is one of the most important goals of nowadays plant production.

## *MATERIALS AND METHODS*

A pot experiment was set up at the greenhouse of the Department of Agricultural Chemistry, Faculty of Agronomy, University of Debrecen during the spring of 2006. Parsley (*Petroselinum tuberosum*) was used as a test plant. We set up this experiment with 12 fertilization combinations, in 4 replications, on 2 different types of

soil: one was calcareous chernozem from Debrecen – Látókép, while the other was a sandy soil from Újfehértó. The main physical and chemical parameters of the two soils are the following:
Látókép: pH ($H_2O$): 6,7; pH(KCl): 5,9; pH($CaCl_2$): 6,23; Humus (%): 2,5; $K_A$: 42;
Újfehértó: pH ($H_2O$): 4,1; pH(KCl): 3,7; pH($CaCl_2$): 4,82; Humus (%): 1,3; $K_A$: 27;

In each pot we added 10 kg air dry state chernozem and 12 kg sandy soil. To each treatment combination we added also nitrogen as $NH_4NO_3$-, phosphorous as $KH_2PO_4$- and potassium as a KCl-solution. We also used bacteria fertilization in two dosages: in the by the producer suggested amount, and in double dosages.
Phylazonit MC bio-fertilizer contains carboxi-methyl-cellulose (CMC), some microelements, soil bacteria species such as Azotobacter chroococcum and Bacillus megaterium, besides these heteroauxin, gibberelin, vitamin B also. Table 1. shows the used treatment combinations:

*Table 1.*

**The treatment combinations of the experiment**

| | | Bacteria-fertilizer ml/pot | | | | |
|---|---|---|---|---|---|---|
| Treatment | N g/pot | chernozem | sand | P g/pot | K g/pot | |
| 1 | 0.2 | 70 | 80 | 0.1 | 0.3 | N1*B1 |
| 2 | 0.2 | 35 | 40 | 0.1 | 0.3 | N1*B2 |
| 3 | 0.2 | - | - | 0.1 | 0.3 | N1*B3 |
| 4 | 0.1 | 70 | 80 | 0.1 | 0.3 | N2*B1 |
| 5 | 0.1 | 35 | 40 | 0.1 | 0.3 | N2*B2 |
| 6 | 0.1 | - | - | 0.1 | 0.3 | N2*B3 |
| 7 | 0.05 | 70 | 80 | 0.1 | 0.3 | N3*B1 |
| 8 | 0.05 | 35 | 40 | 0.1 | 0.3 | N3*B2 |
| 9 | 0.05 | - | - | 0.1 | 0.3 | N3*B3 |
| 10 | - | 70 | 80 | 0.1 | 0.3 | N4*B1 |
| 11 | - | 35 | 40 | 0.1 | 0.3 | N4*B2 |
| 12 | - | - | - | 0.1 | 0.3 | N4*B3 |

Water supply at 60% of the maximal water capacity was ensured for each pot by daily irrigation to a specific weight.
We cut out all plants eight weeks after shooting. At that time soil samples were also taken from each combination and replication. But soil of all treatment combinations remained in the pots through the winter and in the spring of the next year (2007) we added chemical fertilizers – in the same quality and quantity as in the previous year – to each pot. We did not add any Philazonit, for we could study the after effect of the bacteria fertilizer.
Beside the weight we measured the total N-content of plants by dry combustion method (Nagy P.T. 2000). The 0,01 M $CaCl_2$-soluble total N-content (HOUBA et al., 1994) of soil samples were measured by a contiflow equipment (Skalar).

## *RESULTS AND DISCUSSION*

Setting up our experiment we aimed to get results about the effect of a small dose of chemical fertilizer together with bacteria fertilizer on the dry matter production and N-content of parsley plants. We also investigated whether the treatment combinations affected the 0.01M-os $CaCl_2$-soluble N-content of soil until the end of the vegetation period. The experiment was set up on two different soil types: one was from nitrogen well-supplied, contained quite a high amount of humus, regarding its pH it was suitable for microorganisms, slightly acidic – neutral chernozem soil. The other was characterised by a low nitrogen- and humus-content and was an acidic sandy soil. Considering that we ensured the same circumstances for each treatment combination on both soil types, we can compare the results of plants grown on the two soil types.
The experiment lasted two vegetation periods long, so we could investigate the after-effect of bacteria fertilization on the plant and soil parameters, mentioned above.
As the data of the dry matter production of plants grown on the chernozem soil in Table 2. show, N-fertilization had a significant yield-increasing effect in both years. Bacteria fertilization increased the dry matter production of parsley in the first vegetation period in tendencies – but not significantly – while in the second vegetation period we could reveal a positive after effect. In 2007 we found a significantly positive relationship between bacteria fertilization and the dry matter production of parsley.

*Table 2*

**Dry matter production of parsley grown on chernozem soil**

| Dry matter of leaves (g pot$^{-1}$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | | | | | **2007** | | | | |
| N (g pot$^{-1}$) | Philazonit dosages (cm$^3$ pot$^{-1}$) | | | Mean | $LSD_{5\%}$ (N) | Philazonit dosages (cm$^3$ pot$^{-1}$) | | | Mean | $LSD_{5\%}$ (N) |
| | 70 | 35 | 0 | | | 70 | 35 | 0 | | |
| 0.2 | 17.73 | 17.55 | 17.50 | 17.59 | 1.4 | 22.40 | 19.70 | 18.68 | 20.26 | 1.84 |
| 0.1 | 15.65 | 15.13 | 15.13 | 15.31 | | 20.98 | 20.15 | 19.53 | 20.22 | |
| 0.05 | 14.63 | 14.40 | 14.33 | 14.45 | | 19.85 | 20.40 | 15.78 | 18.67 | |
| 0 | 15.60 | 15.63 | 14.70 | 15.31 | | 16.88 | 14.63 | 15.20 | 15.57 | |
| Mean | 15.90 | 15.67 | 15.41 | 15.66 | | 20.02 | 18.72 | 17.30 | 18.68 | |
| $LSD_{5\%}$ (philazonit):1.21 | | | | | | $LSD_{5\%}$ (philazonit):1.59 | | | | |

As the results in Table 3. show, that on the sandy soil the dry matter content of treatments fertilized with nitrogen increased in contrast to the control treatments. But we found hardly any difference between the yield and dry matter of treatment combinations of different nitrogen-dosages.

On this soil type we could not reveal any statistically significant effect of bacteria fertilization on plant production in either of the two vegetation periods. As the data show, in combinations, treated with a higher dose of nitrogen, bacteria fertilization also increased the yield, while in combinations, treated with a lower amount of nitrogen – or even without nitrogen – bacteria fertilization had a decreasing effect on the dry matter production. These results suggest, that microorganisms used this small amount of available nitrogen in the soil for their own growth and reproduction (pentosane-effect).

*Table 3*

**Dry matter production of parsley grown on the sandy soil**

| Dry matter of leaves (g pot$^{-1}$) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | | | | | **2007** | | | | |
| N (g pot$^{-1}$) | Philazonit doses (cm$^3$ pot$^{-1}$) | | | Mean | $LSD_{5\%}$ (N) | Philazonit doses (cm$^3$ pot$^{-1}$) | | | Mean | $LSD_{5\%}$ (N) |
| | 80 | 40 | 0 | | | 80 | 40 | 0 | | |
| 0,2 | 5.43 | 5.65 | 4.43 | 5.17 | 0.85 | 9.1 | 7.78 | 7.55 | 8.14 | 1.20 |
| 0.1 | 5.8 | 4.53 | 4.93 | 5.08 | | 7.6 | 7.13 | 6.95 | 7.23 | |
| 0.05 | 4.75 | 5.05 | 5.0 | 4.93 | | 7.1 | 6.15 | 7.15 | 6.80 | |
| 0 | 4.0 | 4.08 | 4.3 | 4.13 | | 6.68 | 5.75 | 6.35 | 6.26 | |
| Mean | 5.0 | 4.83 | 4.665 | 4.83 | | 7.62 | 6.70 | 7.00 | 7.11 | |
| $LSD_{5\%}$ (philazonit):0.74 | | | | | | $LSD_{5\%}$ (philazonit):1.04 | | | | |

We investigated – among other parameters – the nitrogen content of plants also. Table 4. show the nitrogen-content of plants grown on the chernozem soil. As these results show, nitrogen fertilization increased significantly the nitrogen content of plants in both years. We did not found any significant relationship between bacteria fertilization and the nitrogen content of plants on the chernozem soil in either of the two vegetation periods.

*Table 4*

**Nitrogen content (%) of plants on the chernozem soil**

| N-content (%) of the leaves | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | | | | | **2007** | | | | |
| N (g pot$^{-1}$) | Philazonit dosages (cm$^3$ pot$^{-1}$) | | | Mean | $LSD_{5\%}$ (N) | Philazonit dosages (cm$^3$ pot$^{-1}$) | | | Mean | $LSD_{5\%}$ (N) |
| | 70 | 35 | 0 | | | 70 | 35 | 0 | | |
| 0.2 | 3.43 | 2.58 | 2.68 | 2.90 | 0.3 | 1.64 | 1.45 | 1.45 | 1.51 | 0.10 |
| 0.1 | 2.94 | 2.54 | 2.95 | 2.81 | | 1.49 | 1.36 | 1.35 | 1.40 | |
| 0.05 | 2.93 | 3.05 | 2.33 | 2.77 | | 1.21 | 1.16 | 1.24 | 1.20 | |
| 0 | 2.20 | 1.97 | 2.51 | 2.23 | | 1.36 | 1.49 | 1.46 | 1.44 | |
| Mean | 2.88 | 2.54 | 2.62 | 2.68 | | 1.43 | 1.37 | 1.38 | 1.39 | |
| $LSD_{5\%}$ (philazonit):0.26 | | | | | | $LSD_{5\%}$ (philazonit):0.08 | | | | |

Regarding the nitrogen content of parsley grown on the sandy soil (Table 5.), it can be stated, that with the increasing amount of nitrogen added, the nitrogen concentration in plants increased parallel. The positive effect was proven by the statistical analysis. There was no significant relationship between bacteria fertilization and the nitrogen content of plants during the first vegetation period. In this case we could reveal the same tendency, as by the dry matter production In combinations treated with a higher dose of nitrogen bacteria fertilization had a positive effect on the nitrogen content of plants, while in combinations treated with a lower amount of nitrogen, or in control combinations even this effect was the opposite. During the second year bacteria fertilization increased the nitrogen content of plants.

*Table 5*

**Total N-content in the 0.01M $CaCl_2$-extraction of the chernozem soil (mg/kg)**

| N-content (%) of the leaves | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | | | | | **2007** | | | | |
| N ($g\ pot^{-1}$) | Philazonit dosages ($cm^3\ pot^{-1}$) | | | Mean | $LSD_{5\%}$ (N) | Philazonit dosages ($cm^3\ pot^{-1}$) | | | Mean | $LSD_{5\%}$ (N) |
| | 80 | 40 | 0 | | | 80 | 40 | 0 | | |
| 0.2 | 3.17 | 2.82 | 2.77 | 2.92 | 0.41 | 2.73 | 1.98 | 1.90 | 2.20 | 0.15 |
| 0.1 | 2.55 | 2.46 | 3.17 | 2.73 | | 1.87 | 1.89 | 1.72 | 1.83 | |
| 0.05 | 2.13 | 2.37 | 2.03 | 2.18 | | 1.92 | 1.47 | 1.48 | 1.62 | |
| 0 | 1.87 | 1.91 | 2.61 | 2.13 | | 1.43 | 1.37 | 1.40 | 1.40 | |
| Mean | 2.43 | 2.39 | 2.65 | 2.49 | | 1.99 | 1.68 | 1.63 | 1.77 | |
| $LSD_{5\%}$ (philazonit):0.35 | | | | | | $LSD_{5\%}$ (philazonit):0.13 | | | | |

At the end of each vegetation periods we measured the total nitrogen content of soils using the 0.01M $CaCl_2$-extraction of soils. Our results are shown in Table 6 regarding the chernozem soil, while on the sandy soil in Table 7.

*Table 6*

**Total N-content in the 0.01M $CaCl_2$-extraction of the chernozem soil (mg/kg)**

| Total N-content of soil (mg/kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | | | | | **2007** | | | | |
| N ($g\ pot^{-1}$) | Philazonit dosages ($cm^3\ pot^{-1}$) | | | Mean | $LSD_{5\%}$ (N) | Philazonit dosages ($cm^3\ pot^{-1}$) | | | Mean | $LSD_{5\%}$ (N) |
| | 70 | 35 | 0 | | | 70 | 35 | 0 | | |
| 0.2 | 19.74 | 17.24 | 15.69 | 17.56 | 2.9 | 19.11 | 17.13 | 19.09 | 18.44 | 1.09 |
| 0.1 | 23.28 | 14.81 | 18.02 | 18.7 | | 16.92 | 18.77 | 18.3 | 18.00 | |
| 0.05 | 16.25 | 15.68 | 12.91 | 14.95 | | 16.23 | 18.65 | 18.77 | 17.88 | |
| 0 | 12.02 | 10.07 | 13.6 | 11.90 | | 16.03 | 16.39 | 16.85 | 16.42 | |
| Mean | 17.82 | 14.45 | 15.06 | 15.78 | | 17.07 | 17.74 | 18.25 | 17.69 | |
| $LSD_{5\%}$ (philazonit):2.51 | | | | | | $LSD_{5\%}$ (philazonit):0.94 | | | | |

*Table 7*

**Total N-content in the 0.01M $CaCl_2$-extraction of the sandy soil (mg/kg)**

| Total N-content of soil (mg/kg) | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | **2006** | | | | | **2007** | | | | |
| N ($g\ pot^{-1}$) | Philazonit dosages ($cm^3\ pot^{-1}$) | | | Mean | $LSD_{5\%}$ (N) | Philazonit dosages ($cm^3\ pot^{-1}$) | | | Mean | $LSD_{5\%}$ (N) |
| | 80 | 40 | 0 | | | 80 | 40 | 0 | | |
| 0.2 | 8.4 | 8.38 | 8.29 | 8.36 | 3.9 | 23.08 | 12.83 | 15.09 | 17.00 | 2.49 |
| 0.1 | 6.75 | 6.25 | 5.20 | 6.07 | | 10.50 | 10.90 | 11.14 | 10.85 | |
| 0.05 | 4.84 | 5.44 | 3.48 | 4.59 | | 8.88 | 9.74 | 9.52 | 9.38 | |
| 0 | 4.37 | 4.49 | 5.10 | 4.65 | | 8.43 | 8.95 | 9.85 | 9.08 | |
| Mean | 6.09 | 6.14 | 5.52 | 5.92 | | 12.72 | 10.605 | 11.40 | 11.58 | |
| $LSD_{5\%}$ (philazonit):3.37 | | | | | | $LSD_{5\%}$ (philazonit): 2.15 | | | | |

As the data of Table 6 show during the first vegetation period nitrogen- and bacteria fertilization increased the total nitrogen content of the chernozem soil as well. This effect was proven by the statistical analysis too. The added nitrogen dosages increased this parameter of the soil in the second year, while no positive after effect could be revealed regarding bacteria fertilization.

We got different results on the sandy soil (Table 7). During the first vegetation period the total nitrogen content of the sandy soil – just like that of chernozem soil – increased parallel to the increasing nitrogen dosages. This relationship was underlined by our statistics. Contrarily bacteria fertilization did not have any significant influence on this parameter, but regarding the tendency, it can be stated, the it decreased the nitrogen content of the sandy soil we got the same relationship for the second vegetation period too.

These results – we could evaluate so far – suggest, that bacteria fertilization on the chernozem soil sets its positive effect on the yield rather in the second year.

We could not reveal any yield-increasing effect on the acidic, sandy soil with low humus content. Adding bacteria fertilizers on this soil type has not got any effect – as our results show. But other experiments and investigations are needed in the future to draw further conclusions.

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# A BAKTÉRIUMTRÁGYÁZÁS UTÓHATÁSÁNAK VIZSGÁLATA TENYÉSZEDÉNYKÍSÉRLETBEN