
Original scientific paper

Comparison of effects of different biofertilisers on early development of cucumber and wheat seedlings

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Abstract

The yield and the dry matter accumulation of crop plants decrease under unfavourable environmental circumstances. The uptake of nutrients by the roots is a dynamic and complex/complicated mechanism. Our aim were to prove the positive role of bio-fertilisers RhizoVital, Proradix, Phylazonit MC, Phylazonit CE and Kelpak on the nutrient uptake, grown, root morphology and biomass allocation between roots and shoots on the selected plants, growing in climate chamber on nutrient solution. To minimize the input, new technologies were developed, as the use of bacterium containing fertilizers. To use these bio-fertilizers the uptake of nutrients, and the total organic matter production will be increased. The effects of different microorganisms on wheat and cucumber seedlings were examined in our experiments. It is proved by our experiments that the growth and development of treated plants increased when the bio-fertilizer Rhizovital, that is a *Bacillus amyloliquefaciens* containing preparatum, was used. The advantageous effects of Phylazonit MC were also observed. The root development was more intensive, and consequently the green mass production was higher.

Key words: nutrient uptake, bio-fertilizer, PGPR

Introduction

Nowadays, the fast growing investments and the change of global climate make the agricultural production more difficult. To minimize the input new technologies were developed, as the use of bacterium containing fertilizers. The bio-fertilizers containing bacteria strains, wherewith prove the nutrient uptake of plants. The PGRB (plant-growth-promoting rhizobacteria) are living microorganisms association with host plants in rhizosphere, therefor increase the growth of plant (Vessey, 2003).

Contents of microelements in crops growing under micronutrient deficient circumstances are low, which has unfavourable effect on health of population living in that area. The so-called „green revolution”, when the production of agricultural production was doubled, was the consequence of use of mineral fertilizers in developed countries as well (Loneragen, 1997). The increase of food production was in line with the dramatic increase of use of fertilizers in the last 40 years. The use of nitrogen was about 7, and the phosphorous 3,5 times higher than in the former period, while expansion of agricultural fields was only 10%. In parallel with the intensive use of macronutrient fertilizers increasing deficiency symptoms (iron and zinc) were observed in several countries. Around 30 % of soils are iron deficient in the World. To maintain the iron deficiency is expensive. These facts lead to the investigation of adaptation mechanisms of different plant species. Marschner et al. (1986) reported about two main adaptation mechanism to iron deficiency.

The plants of Strategy I. release by their roots protons and electrons, and make the rhizosphere pH lower. The plants belonging to the Strategy I group are the dicots. The mechanisms will be activated under iron deficiency. The grasses belong to the second - Strategy II- group. Pethő (1992) and Lévai (1998) observed the release of cyclic hydroxamic acids by the roots of corn, and it was proved their role in iron uptake. The amounts of organic matter – mainly organic acids- released by the roots can be more than 25% of net photosynthesis (Lynch and Whipps, 1990). The release of organic compounds depend on stress intensity (Lévai et al., 2008) The soil pH is one of the most important environmental factors, which determines the productivity of soils, and the success of plant production. The experiments were conducted in Life Science Building of Debrecen University, and in Stuttgart Hohenheim University.

Material and methods

In this study, we used as experimental plants cucumber (*Cucumis sativum* L. var. Vorgebirgstrauben) and spring wheat (*Triticum aestivum* L. var. Paragon). The seeds were germinated on moistened filter paper at 25 °C. In pretreatment were the seeds surface sterilized at cucumber: 10 min in 1,1% Na-hypochlorite and 5% ethanol, 3x washed with 2,5mM CaSO₄ and at wheat: 4 min in 30% H₂O₂, 3 min in 70 % ethanol, 3x washed with 2,5mM CaSO₄. The seedlings were grown for 11 days under controlled conditions (24°C), in 2.5 L aerated standard nutrient solution for dicotyledonous and monocotyledonous plants, respectively: each pot with 6 seedlings of spring wheat resp. 4 seedlings of cucumber in 4 replicates.



Picture 1: 11 days old cucumber and wheat seedlings on nutrient solution (Hohenheim, 2008)

The seedlings were then transferred to a continuously aerated nutrient solution of the following composition: 2,0 mM Ca(NO₃)₂, 0,7 mM K₂SO₄, 0,5 mM MgSO₄, 0,1 mM KH₂PO₄, 0,1 mM KCl, 1μM H₃BO₃, 1μM MnSO₄, 0,25 μM CuSO₄, 0,01 μM (NH₄)₆Mo₇O₂₄. The nutrient solution of cucumber contains 10μM H₃BO₃. The iron as Fe-EDTA in a concentration of 10⁻⁴M was given to the nutrient solution. Plant cultivation in nutrient solution (hydroponics) enriched with bio-fertilizers for 11 days. The five commercial bio-fertilizers based on *Bacillus amyloliquefaciens* strain FZB42 (RhizoVital[®], ABiTEP, Berlin, Germany), *Pseudomonas proradix* (Proradix[®], Sourcon-Padana, Tübingen, Germany), *Bacillus megatherium* var. *phosphaticum* and *Azotobacter chroococcum* (Phylazonit MC[®] Corax-Bioner, Hungary) and additional 2 bacterial strain

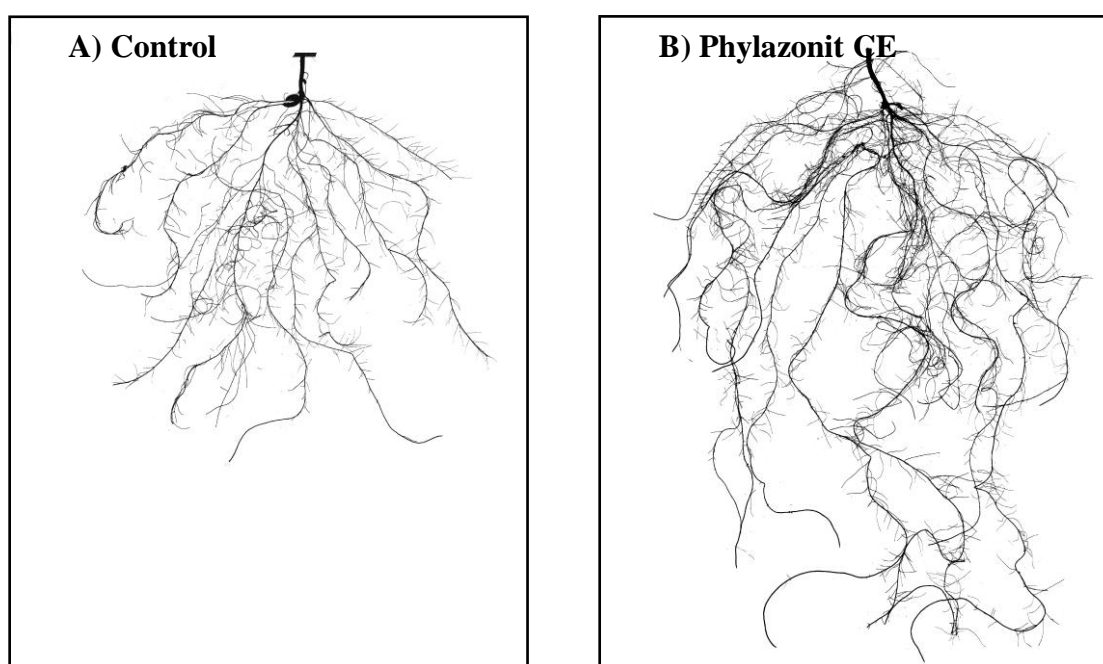
with *Pseudomonas putida* and *Bacillus* sp. (Phylazonit CE[®] Corax-Bioner, Hungary) and a liquid extract from brown algae (Kelpak[®], Kelp Products, Simon's Town, South Africa).

The seedlings were grown under controlled environmental conditions (light/dark regime 10/14 h at 24/20 °C, relative humidity 65-70% and a photosynthetic photon flux of 390 mEm⁻²s⁻¹ at plant height. The contents of elements were measured by ICP. The relative chlorophyll contents were measured with SPAD 501 (Minolta), the pH with OPTIMA 200A (USA) pH meter.

Results and discussion

The commercial bio-fertilisers contain living microorganisms colonize the rhizosphere or the interior of plants and promote growth the biological N₂ fixation (*Rhizobium*, *Azotobacter*), increasing the availability of nutrients to rhizosphere, inducing increases in root surface area (Phytohormons, root resp.), enhancing other beneficial symbioses of the host (*helper bact. IAA*) and suppression of plant pathogens and induced resistance (Vessey, 2003.).

The bio-fertiliser Phylazonit MC[®] influenced the root morphology and the number of lateral roots per plant in cucumber. The root of treated plant was significant higher from the control. The results can be seen on picture 2.

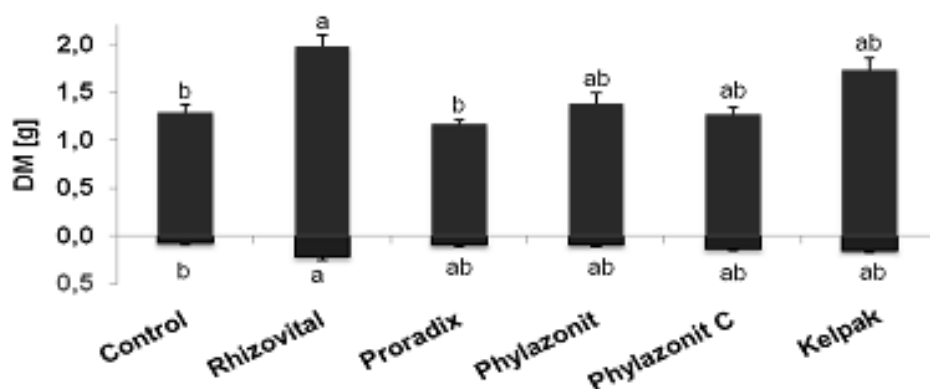


Picture 2: 11 days old cucumber root biomass

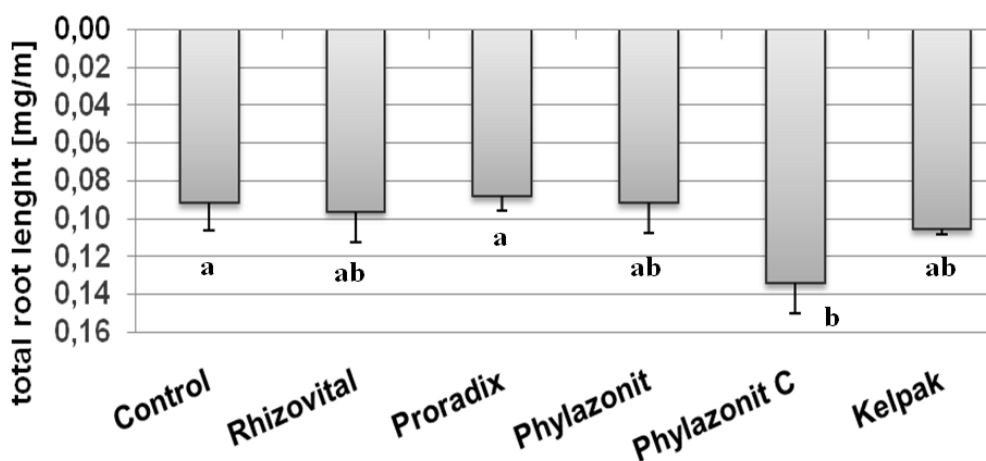
Significant difference was observed between Rhizovital and control cucumber plants in dry matter. The *Bacillus amyloliquefaciens* FZB42 strain stimulation the grown and development of host plant, accordingly the dry matter of Rhizovital treated plants was significant higher (Graph 1.).

Bio-fertilizer treated seedlings showed in tendency a higher biomass allocation to the root, without Proradix (Graph 1.).

Phylazonit CE enhanced the root development and the application of bio-fertiliser Phylazonit CE significantly increased the total root length in wheat (Graph 2.). The positive effects of microorganisms on wheat seedlings were observed.



Graph 1: shoot and root dry matter of cucumber



Graph 2: root length density of wheat

Conclusions

To use these bio-fertilizers the uptake of nutrients, and the total organic matter production will be increased. The effects of different microorganisms on wheat and cucumber seedlings were examined in our experiments. It is proved by our experiments, that the growth and development of treated plants increased when the bio-fertilizer Rhizovital, that is a *Bacillus amyloliquefaciens* containing preparatum, was used. The advantageous effects of Phylazonit MC were also observed. The root development was more intensive, and consequently the green mass production was higher.

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