Biorational use in Hungarian agriculture

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Introduction, Abstract

Microbial inoculums, used in agri/horticulture belongs to the so called „crop-improving products". Generally it is called as „biofertilizers" or as „bacterium-fertilizers" by the farmers. Registration of those products are based on the XLVI. law, the 003/2003/EK directive and the 36/2006 (V.18) FVM (Hung. Min. Agric) directive. Beyond the wanted 1) fertilizer, nutrient and biostimulation effects, other potential impact, such as 2) biocontrolling, and 3) soil-structure improving are also possible (**Table 1**). Data base for Hungarian plant protecting products: https://novenyvedoszer.nebih.gov/engedelykereso/kereso.
The aim of various soil-plant inoculums are to find **bioalternatives of pesticides, xenobiotics**, especially among **organic agricultural practices**. Additional necessity and an emerging issue for those products to have beneficial impacts on soil-structure and secondary aggregate stability. Main effects therefore could be different, but there are overlaps occasionally as a function of the host-plants, the soil-characteristics, the soil-management practices and also if we consider the interactions among the different soil organisms.

Microbes in Hungarian products

Presently there are **104** registered, commetionalised products, among them it is **44**, which can be used in organic agricultural practices in Hungary. Potential **biorationals** belongs mainly to the „biopesticide, biocontrol agent" category. Beyond the generally accepted soil-amendments there are increasing demand for the **shoot-applyed biostimulants**, as secondary, additional treatments in plant production (listed in **Table 2**).

Table 2: *Potential commertialised biostimulants and biofertilizers*

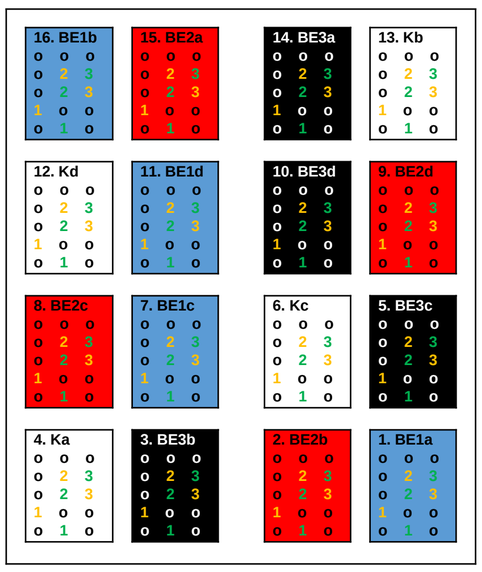
1. Humic substances, organic extracts
2. Complex organic materials
3. Beneficial chemical compounds
4. Inorganic salts
5. Alga exctracts, bio-plasma
6. Chitin and chitozan compounds
7. Anti-transpirants
8. Free amino-acids

1. Inorganic industrial fertilizers
2. Natural inorganic fertilizers
3. Registered organic fertilizers
4. Composts
5. Vermicomposts
6. Soil-improvers, soil-conditioners
7. Rooting substrates, hormones
8. Microbiológical products

Table 1: *Main types and potential activities of microorganisms in Hungarian products*

	Bacteria	Fungi	Algi
Biofertilizers, biostimulants			
Biological Nitrogen (N_2) fixation	***Azospirillum*** *brasiliense, irakense, lipoferum;* ***Azotobacter****, beijerinckii, vinelandii, chroococcum;* ***Nitrobacter*** *vulgaris;* ***Nitrosomonas*** *communis, nitrosa; Rhizobium leguminosarum, loti;* ***Bradyrhizobium*** *japonicum*		***Cyanobacterium*** sp., i.e „blue algi"
Phosphor-mobilisation	***Bacillus*** *circulans, licheniformis, megaterium, polymyxa, simplex, subtilis*	***Glomus*** *intraradices, mosseae*, AMF mícorrhiza fungi	
Cellulose-decomposition	***Cellulomonas*** *cellulosea, flavigena, uda;* ***Cellvibrio*** *fibrivorans, flavescens, vulgaris ostraviensis; Streptococcus termophilus, albidoflavus, albus, lactis;* ***Streptomyces*** *cellulosae, griseoviridis*	Aspergillus niger, A. oryzae; Mucor hiemalis; Polyangum cellulosum	
Biopesticides, biocontrol agents			
Hormon-production	***Azospirillum*** *brasilense, lipoferum,* ***Herbaspirillum*** *seropedicae*		***Chlamydomonas*** *reinhardtii;* ***Chlorella*** *vulgaris;* ***Scenedesmus*** *obtisausculus*
Siderphor-effect, better Fe-nutrition	***Pseudomonas*** *cellulosa, fluorescens, chlororaphis, jessenii, putida, stutzeri;* ***Paenibacillus*** *amylolyticus, macerans, peoriae, polymyxa*		
Antagonistic effect in plant protection	***Bacillus*** *thüringiensis, licheniformis, amylolíquefaciens*	***Coniothyrium*** *minitans* ***Penicillium*** *glaucum;* ***Trichoderma*** *reseei, asperelum, harzianum;* ***Beauveria*** *bassiana*	
Biosoils, stress–reduction			
Compacted soil – fermentative degradation	***Lactobacillus*** *acidophilus, delbrueckii, fermentum, casei, plantarum, lactis;* ***Bifidobacterium*** *animalis, bifidum, longum*	***Saccharomyces*** *cerevisiae,* ***Aspergillus*** *niger,* other yeast and moulds fungi	

Case study with bioeffectors and biorationals on tomato



Legends:
=BE1 (*Trichoderma harzianum* strain T-22 /Trianum P/)
=BE2 (*Pseudomonas* sp. /Proradix WP/)
=BE3 (*Bacillus amyloliquefaciens* /Rhizo Vital 42 Fl/)
=K (Control)
MTD = Hungarian *Trichoderma*
CF = Combifector treatment
p = treatment at seedlings
k = treatment at planting
pk = treatment at seedlings and planting
o = tomato plant
1, 2, 3 = plant treatment with algae extract (BioAtlantis)
1, 2, 3 = plant treatment with nettle extract

Field experiments were performed to study the effect of **bio-effector and biorational treatments** on the growth of tomato (*Lycopersicon aesculentum* var. Mobil) at the experimental field of **Szent István University,** Faculty of Horticulture (Soroksár, Hungary, in 2015, 2016). There was 15 plants per 5 m^2 plots planted in 4 replication. Soil was **slightly humus** (1,46 %) sand; pH 7.3; P_2O_5: 769 mg.kg^{-1} soil (very high), NO_2+NO_3-N: 7,55-; K_2O: 221 mg kg^{-1}. **Viano Mixprof** organic fertilizer, N:P:K=9:3:3 (59 kg N ha^{-1}); 660 kg/ha, 29 g/plant and **Patentkali** (293 kg K; 72 kg Mg ha^{-1}); 1200 kg/ha, 53.3 g/plant were used. Shoot treatment were applied in a beeweekly period with **algae extract** (super 50, Bioatlantis) 3-times, after the plantation. Other plants were sprayed by **nettle extract**. Cuproxat FW (190mg/L Cu) were used against *Phytophtora* diseases, 2-times during the vegetation periods. Yield (quantity, quality) and Brix value of tomato fruits were evaluated.

Fruit quantity and quality of tomato

Quantity of healthy fruits were measured. The size of intact tomato fruits and also the total yield/plants were significantly enhanced by BE-3 treatment (**Fig.1**). Comparing the effect of various *Trichoderma* products, a significant reduction of infected (diseased) tomato fruits were recorded, in case of GTD (German product) and the MTD (Hungarian product), There were 2-4 infected piece less with BE treatments.(**Fig. 2**).

Brix value of riped tomato fruits were assessed after the harvest in 2016. Biorational treatments were used. Result is shown in **Fig. 3**. Every **BE treatments were improving the Brix values** in comparison with the controls (K). The **nettle extract (S)** had the most efficient result at the K (control), the BE2 and BE3 treatments. **Algal (Super 50**, Bioatlantis) had positive effect on control plants. Among Brix values and tomato sugar content a positive correlation was realized (data not shown).

Fig 1 Average quantity of intact fruits by treatments

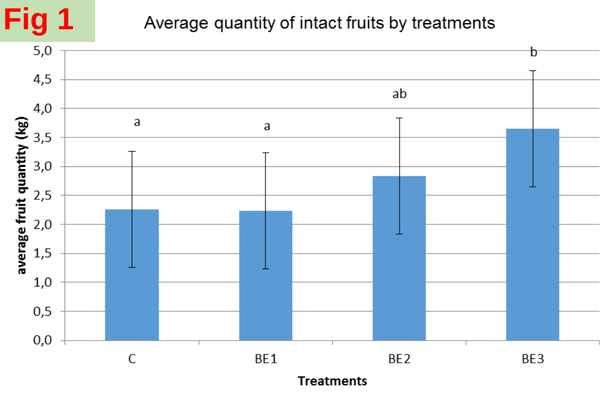


Fig 2 Infected tomato piece/plant, 2015

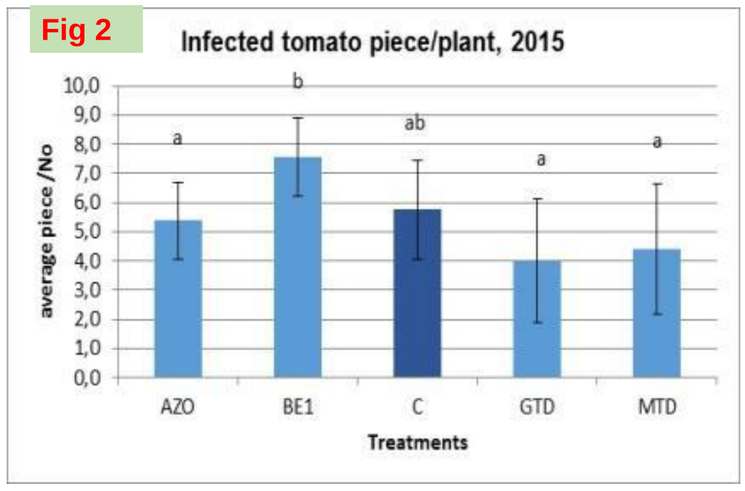
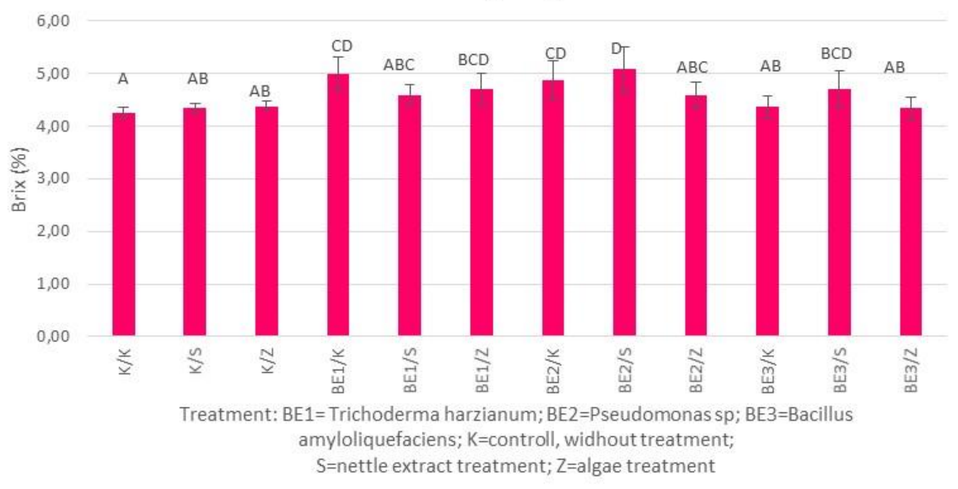


Fig 3 Tomato fruit dry matter content (Brix) of open field experiment per treatment (2016)



Treatment: BE1= Trichoderma harzianum; BE2=Pseudomonas sp; BE3=Bacillus amyloliquefaciens; K=controll, widhout treatment; S=nettle extract treatment; Z=algae treatment

Conclusions

During the vegetation Cu-treatments were reduced to 2, from the acceptable 5-times. There were 1520 g/ha Cu applied, instead of the potentially possible 3800 g/ha. Bioeffector *Trichoderma* fungi in combination with biorational leaf-treatments can provide good alternative of fungicide application among the organic agricultural practices. Beyond the biofertilizer effects of bioeffectors, focus should be given for the plant protective solutions and also for the quality (size, sugar-acid ratio) of the tomato fruits. Quality parameters in soil-plant-human food chain needs more attention, more particularly with biorational application.

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Supports of Eu-Kp7 Biofector (www.biofector.info) „*Resource preservation by application of bioeffectors in European crop production*" (GA 312117), and of producers for providing BE products are highly acknowledged