BIOPRODUCTS WITH LIVING MICROORGANISMS USED IN AGRICULTURE

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Abstract: Modern agriculture means mass industrial production of agricultural plants for food and fodder with high level productivity hybrids and varieties, and modern mechanical machineries and application of chemicals and fertilizers. It has some side effects too, pollution of soil, water, destruction of biodiversity, and so on. In the last 50 years, many countries in special in course of development, tried to use bioproducts to supply their needs for fertilization and control of pests and pathogens using biotechnology, with the help of different beneficial microorganisms. This paper reviews the tendency and explains the achievements in this field of research and the dawn of a new era in international and national agriculture.

Key words*: bioproducts, biofertilizers, biopesticides, agricultural biotechnology*

INTRODUCTION

The modern agriculture tendency is to use less pesticides and fertilizers in order to obtain superior production with less chemicals residues, according to the UE Commission requirements. Anyway such changes are required by authorities and by the large public for a new sanogenetics way of life and feeding.

From almost 40 years, many organisations are supporting the sustainable development and agriculture in all the countries and in especially in the countries in course of development, where the finance for chemical pesticides and fertilizers are scarce, the biofertilizes and biopesticides are much cheaper, and easy to use, and have no chemical hazard for humans.

PRINCIPLES OF BIOPRODUCTS

The scientific basis of bioproducts is characteristic of the used microorganism. Generally, there are microorganisms from environment, form soil, from plants, from different pests. There are a lots of microorganisms from soil living in the rhizosphere (Compant et al, 2010), endophytes living in plants as symbionts (Jones et al., 2007) or only using the plants as habitat in differents organs (de Oliveira Costa et al., 2012) which have beneficial effects for plants, due to their characteristics.

1. Fertilization. Some of microorganisms are good for plant growth stimulation, in this categories being both fungi and bacteria.

1.1. Nitrogen fixation is one of the most important roles in agroecosystem providing the necessary nitrogen for plants from non-conventional source, from atmosphere (Battacharjee et al, 2008), there are strain of *Azospirillum*, *Azotobacter,* and so on.

1.2. Solubilization of phosphates is another characteristics of some strains of microorganisms (Sharma et al., 2013) being bacterial strains like *Pseudomonas* and differents *Bacillus*, or/and fungi *Aspergillu*s and *Penicillium*. The mobilisation of potassium from complex compounds

form soil is possible too (Zhang & Kong, 2014), belonging to genera *Pantotea*, *Enterobacter*, *Microbacterium*, and others.

1.3. Stimulation of plants growth, by releasing of indole compounds, like IAA, of siderophores and other stimulating substances by strains of *Azospirillum, Burckholderia, Bacillus, Klebsiella* and so on (de Souza et al., 2015).

2. Activation of plant defence is other feature of some microorganisms, showing the powerfull relations in the ecosystem, helping plants to face abiotic stress (Yang et al., 2008).

3. Antagonism against plant pathogens. Some bacteria showed a clear antagonistic effect in vitro and in vivo against plants pathogens. Strains of *Streptomyces, Micromonspora, Actinoplanes* have antagonistic activity against *Rhizoctonia Fusarium*. Recent researches showed that *Bacillus* strains isolated from corn seeds can produce lipopeptides with antifungal effect (Gond et al., 2015) like iturin A, fengycin and bacillomycin and with antibiotic effects. The lipopeptides are cyclic compounds with low molecular weight produced by strains of *Bacillus* and *Pseudomonas* spp. (Gond et al., 2015) for example, *Bacillus amyloliquefaciens* (Xun-Chao et al., 2013).

4. Pathogenic fungi and bacteria used against pests. Pests is one of the main destructive elements for cultivated plants during vegetation and post harvest in deposits, that finding solutions to control them is essential, in specially solutions non harmful for peoples and environment.

EXAMPLES OF BIOPRODUCTS AND THEIR USE

The researches on fungi and bacteria which can be useful for agriculture, generates a number of strains, method of growth and conditioning, leading to fabrication of bioproducts to be used for fertilization and pest/phytopathogens control for agricultural crops. In special in low developed countries, this was an important issue, because the high costs of chemicals for agriculture, being a cheaper and ecological alternative. Practically, countries like India, Malaysia, China, Taiwan, South Korea, are leaders in such production and use of eco-friendly bioproducts (biofertilizers and biopesticides), but other countries began to work and to invest in this field of activity. A very little part of the products are shown in Table 1, being only few examples.

Table 1. Examples of bioproducts obtained worldwide (biofertilizers and biopesticides)

Product	Microorganism	Used for	Application	Producer /Land
Biofertilizers				
BIO 'N' MORE Azotobacter	*Azotobacter sp.*	Biofertilization N fixation	Vegetable crops	SKS Latvia
Azotobacterin	*Azotobacter sp.*	Nitrogen fixation	Different crops	Latvia by Bioefekt Ltd
PRO2MAX AGRO	Mixture of Bacillus spp., Pseudomonas spp., *Trichoderma viride.*	Biostimulation of plants and biocontrol of fungi	Grape, Potato, Tomato, Rose, Gerbera, legumes	Green Aquatech India
AZOSPI POWER	*Azospirillum lipoferum*	K and P mobilizing bacteria products and free nitrogen fixing bacteria	Many cultures	KN Biosciences
VAM Power	Mycorhiza fungi	For better NPK uptake, P solubilisation	Different crops	KN Biosciences

BIO-GAIN ™ Microbial Fertilizer	A mixture of microorganisms Bacillus, Azotobacter,	stimulating nitrogen fixation restoring natural soil fertility	Different crops	Shandong Sukahan Bio-technology Co., Ltd.
Biopesticides				
AGO biocontrol Bassiana 50	*Beauveria bassiana*	Coleoptera, Homoptera, Lepidoptera, Diptera	Different crops	AGO biocontrol Colombia
Ago Biocontrol Trichoderma 50	*Trichoderma harzianum*	Against Alternaria, Rhizoctonia, Fusarium	Vegetable crops	AGO biocontrol Colombia
MYCOTAL	*Verticillum lecani*	Trips whiteflies	Vegetable crops	Koppert Biol Systems Netherlands B.V.

There are many state agencies, NGOs whitch are promoting and supporting the used of liquid formulations in agriculture as an efficient soil health restoring solutions (Pindi, 2012). The global market will be in 2022 of 1.66 billion dollars (globenewswire.com) and the growth of biofertilizers 13.2% per year. The growth of agriculture for countries from South East Asia will be impressive. The same, the market for phosphate solubilising bacteria has its growing trend. Some examples of such productive companies are Camson Bio Technologies Ltd., Eagle plant protect pvt. Ltd. Emerald, Flora group of companies, Green land bio sciences, Gujarat State Fertilizers & Chemicals Ltd. Harison agro rasayan pvt. Ltd., Lallemand Inc., Madras Fertilizers Ltd., Majestic agronomics, Manidharma biotech pvt. Ltd., Manshya agronomics,Md Biocoals pvt ltd., National Fertilizers Ltd., Novozymes A/S, Nutramax Laboratories Inc., Rashtriya Chemicals & Fertilizers Ltd., Rizobacter Argentina S.A.

BIOPRODUCTS MADE IN ROMANIA

In Romania, there are few valuable researches concerning biofertilizers and biopesticides patented and tested in the fields. The scientific base is the complex ecological biochemical relation with plants. In our country there are studies to obtain such products of isolation of bacteria strains from plants and endophytic strains testing their capacity of fertilization and antagonism and growing them in different culture media (Figure 1, a and b), and including them for example in special mixtures of alginate and others forming granules (Figure 2).

The Research Development Institute for Plant Protection Bucharest (RDIPP) elaborates many biofertilizers and biopeticides (Table 2), as BioProSol (Figure 3a) and BioProSil-It (Figure 3b).

Table 2. Bioproducts obtained in Romania in the Research-Development Institute for Plant Protection

Products	Microorganisms	Used for	Application	Producer
Biofertilizers				
Azostim F9 PTS	*Azospirillum brasiliense*,	Plants stimulating effect N fixation	Sunflower, Cereals	RDIPP
Nitrofix 6 PTS	*Bradyrhizobium japonicum*	N fixation Stimulation of plants growth	Treatment of seeds	RDIPP
Biopesticides				
BioProSol	*Beauveria bassiana*	*Leptinotarsa decemlineata*	Potato crops	

BioProSil-It	*Beauveria bassiana*	*Ips typographus*	Treatment of tree bark	RDIPP
BioMelCon (G)	*Beauveria brongniartii*	*Melolontha melolontha*	Agricultural crops and forest	RDIPP
PEX TA PU	*Bacillus thuringiensis Berliner var. kurstaki*	*Plodia interpunctella Hyphantria cunea* (L1)	Stored production, horticulture	RDIPP
Trichosemin 25 PTS	*Trichoderma viride*	Soil borne pathogens	Treatment of sun flower seeds	RDIPP

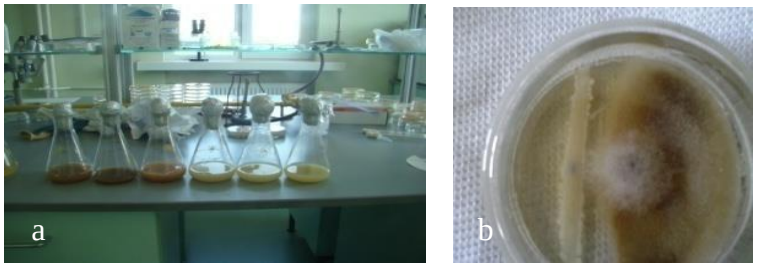

Figure 1. a. Growth of the PGSP strains in laboratory in different culture media; **b.** Antagonism of bacterial strains against phytopathogenic fungi

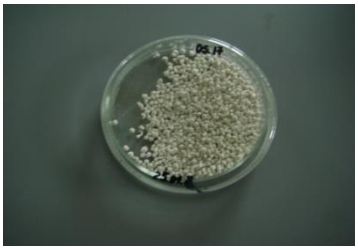

Figure 2. Granules with bacterial biofertilizers strains embedded inside

Figure 3. Bioproducts patented in Romania, resulted from research activity:
a. BioProSol, **b.** BioProSil-It

CONCLUSIONS

Further we must enhance our efforts to promote the products, to obtain facilities from Government and including financial and legal support in order to develop the new products and to launch them in the market.

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