Development of technology for the production of microbial enriched mineral fertilizers

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Abstract

„BIOFERTIL" is a Polish national research program, planned for years 2018-2022. The aim of the project is to develop innovative biofertilizers based on mineral fertilizers and selected microorganisms dedicated to land reclamation technologies and increase crop production. The basis for the biofertilizers are microorganisms collected in SYMBIOBANK of the Research Institute of Horticulture, Poland. Multiplied microorganisms and mineral fertilizers were used by ŁUKASIEWICZ-INS to produce experimental batches of the products. Their effectiveness in crop production and technology to apply them is assessed by InHort and IUNG, while their effects on soil properties are determined by IA PAN. The research will result in recommendations that will be disseminated among farmers and fruit and vegetable growers. The use of the new biofertilizers will increase the soil quality parameters, availability of mineral compounds and their uptake by plants, and thus the crop yield and its quality. The developed biofertilizers and technologies will raise the competitiveness of GRUPA AZOTY, Polish farmers and entrepreneurs, and strengthen their market position.

Introduction

Without innovative and environmentally friendly technologies, modern agriculture, especially crop production, will be inadequate to feed the growing population in the face of the progressive degradation of agricultural soils. It is estimated that 89% of the soils in Poland are of low and very low fertility, including more than 60% of soils with a pH below 5.5, while in other EU countries over 30% of arable soils are degraded. Most of agricultural soils in Poland and the EU are low in organic matter. In this context, it is vital to search for environmentally friendly methods of increasing the organic matter and humus content in agricultural soils, which will increase their biological activity, water content and sorption capacity, and improve the soil structure and gas exchange between the soil and atmosphere (Sas-Paszt et al. 2014). In an attempt to meet these expectations, researchers and people concerned with agricultural practices have shown a growing interest in the use of microbiologically enriched fertilizers.

Compliance of the project with the EU programmes

1) Food security and food safety;
2) Rational management of natural resources, with particular emphasis on water management;
3) Counteracting and adaptation to climate change, with particular emphasis on agriculture.

Consortium members:

- **InHort**- Research Institute of Horticulture, Skierniewice, Poland
- **Ł- INS**- Łukasiewicz- Institute of New Chemical Syntheses, Pulawy, Poland
- **IUNG**- Institute of Soil Science and Plant Cultivation, Pulawy, Poland
- **IA PAN**- Institute of Agrophysics of Polish Academy of Science, Lublin, Poland
- **GA**- GRUPA AZOTY – the biggest Polish and 2nd European fertilizers producer, Poland

Microorganisms role:

- ability to dissolve phosphorus compounds not readily available to plants,
- production of terpenoids, which are important as nitrification inhibitors
- production of auxins, antibiotics and siderophores,
- biofilm formation,
- antagonistic activity against soil pathogens (bio-pesticide).

WP	Partners	Activities
1	InHort, Ł-INS, GA	Production technology of microbiologically enriched fertilizers
2	IA PAN	Testing of effectiveness of biofertilizers in improving bio-physico-chemical properties of degraded and agricultural soils
3	InHort	Effect of biofertilizers on growth and yield of horticultural plants and on soil microbiology
4	IUNG	Effect of biofertilizers on growth and yield of arable crop plants and on improving soil fertility
5	InHort	Assessment of the impact of biofertilizer use on water potential and macro- and microelement content in the soil and plants
6	Ł-INS, GA	Preparation for implementation, dissemination and commercialization of research results and newly developed biofertilizers

Project realization

Three different mineral fertilizers produced by Grupa Azoty were selected for the project purposes. A two mineral fertilizers and selected bacteria were processed in order to achieve bio-fertilizer of core-shell structure. Laboratory scale tests of biofertilizer manufacturing using several techniques were carried out in Ł-INS in order to choose the highest microbial survival conditions. After the positive results of laboratory tests, semi-technical scale production has started.

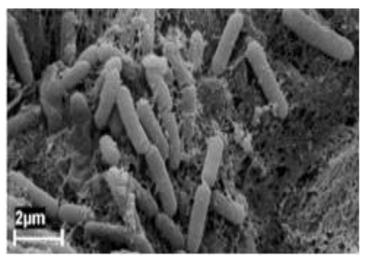
Microorganisms as an endospore form were incorporated onto fertilizer granules surface using drum granulation method with special water free binders at increased temperature. The mass fraction of microorganisms with a carrier and binders is 20% of total bioferilizer mass, while mineral core is the rest (80%). The two bio- products based on P(Ca) and NPK fertilizers consisting of microorganism in a concentration > $3 \cdot 10^7$ CFU/g were produced between years 2018-2021 in a scale of 1600kg at semi-technical plant in INS/Pulawy. Bio-fertilizers were then sent to project partners for pot and field experiments in order to evaluate their effectiveness in crop production at the vegetation periods 2018-21.

Phospohorus Fertilizer Super Fosdar 40 P (Ca) 40-(10)

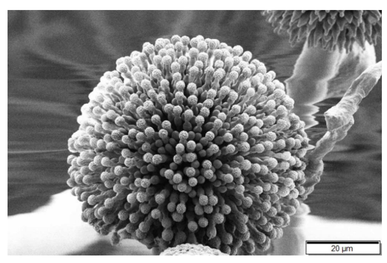
Compound Fertilizer Polifoska Krzem NPK 6-12-34

Nitrogen Fertilizer Pulrea N 46

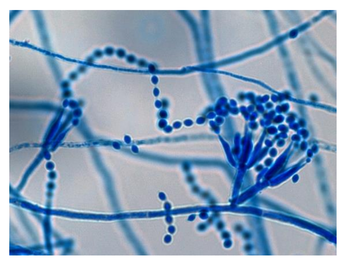
Bacillus amyloliquefaciens



Paenibacillus polymyxa



Aspergillus niger



Paecillomyces lilacinus

Agricultural research on bio-fertilizers is currently continued, but already three-year results indicate an increase in yield, increased plant resistance to drought stress, and improved phosphorus bioavailability in the case of biologically enriched P (Ca) fertilizer. Detailed agricultural tests result will be available after the project is done.

Semi-technical biofertilizers granulation plant at INS/Poland

Semi-technical scale product: NKP 5-10-27 Bio-Fertilizer

References:

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