Development of technology for the production of microbial enriched mineral fertilizers

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Keywords: agricutlture, biofertilizer, beneficial microorganisms.

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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.

Purpose of the project

The aim of the project is to develop innovative microbiologically enriched biofertilizers and to assess the effects of their use in crop production and in improving the bio-physico-chemical properties of arable and degraded soils. The biofertilizers will be produced by combining urea, NPK mineral fertilizers with humic acids and precisely characterized beneficial microorganisms with well-defined properties in the stimulation of the growth and yield performance of crop plants and improvement of the productivity of soils.

The BIO-FERTIL is carried out by the consortium memebers:

- Research Institute of Horticulture, Skierniewice, Poland (Leader)
- Łukasiewicz Reseach Network - New Chemical Syntheses Institute, Puławy, Poland
- Institute of Soil Science and Plant Cultivation – State Research Institute, Puławy, Poland
- Institute of Agrophysics in Lublin, Poland
- GRUPA AZOTY, Puławy, Poland

Project activities

The project is organized into 6 work packages (WP) (Table 1).

Table 1. Project activities.

WP no.	Activities
1	Production technology of microbiologically enriched fertilizers
2	Effectiveness of biofertilizers in improving bio-physico-chemical properties of degraded and agricultural soils
3	Effect of biofertilizers on growth and yield of horticultural plants and on soil microbiology
4	Effect of biofertilizers on growth and yield of arable crop plants and on improving soil fertility
5	Assessment of the impact of biofertilizer use on water potential and macro- and microelement content in the soil and plants
6	Preparation for implementation, dissemination and commercialization of research results and newly developed biofertilizers

In the project a five microorganisms were tested: *Bacillus amyloliquefaciens, Bacillus Megaterium, Paenibacillus Polymyxa, Aspergilllus Niger*, and *Purpureocillium lilacinus*. Bacteria were prepared at dextrose as a carrier, while fungi at corn flour. Expected role of the microorganisms was to: ability to dissolve phosphorus compounds not readily available to plants, production of auxins, antibiotics and siderophores, biofilm formation, antagonistic activity against soil pathogens (bio-pesticide). Microorganisms were bounded with three types of mineral fertilizers: phospohorus fertilizer P (Ca) 40-(10), compound fertilizer NPK 6-12-34 and urea N 46. The main problem was to obtain a stable product with a shelf life of a few months without loss of bioactivity. The project developed a technology for producing bio-fertilizers using a low-melting binder without the use of water in a technological process. The most promising results were obtained using medium-chain polyethylene glycol as a binder. For the purposes of the project a two bio- products based on P (Ca) and NPK fertilizers consisting of microorganism in a concentration of $3 \cdot 10^7$ CFU/g were produced in 2018 and 2019 at semi-technical plant in INS/Pulawy in a scale of 800 kg and sent to project partners for pot and field experiments in order to evaluate their effectiveness in crop production at the vegetation period 2018. Field studies on maize and wheat gave promising results in the first two years. There was proven the greater biomass accumulation of the plants through the vegetation period and better root mass formation under biofertilizers as compared to the conventional ones. The enrichment of bacteria made it possible to reduce the total rate of bioferilizers to obtain the comparable grain yield. Project results will be evaluated after the completion of agricultural research in the vegetation season of 2020 year.

Project duration

36 months: February 2018 – January 2021

References

Sas Paszt L, Pruski K, Żurawicz E, Sumorok B, Derkowska E., Głuszek S. 2014. The effect of organic mulches and mycorrhizal substrate on growth, yield and quality of ‘Gold Milenium’ apples on M.9 rootstock. Canadian Journal of Plant Science 94(2): 281-291

Acknowledgements

The project is co-financed by the National Centre for Research and Development of Poland within BIOSTRATEG Programme under Grant No. BIOSTRATEG3/347464/5/NCBR/2017.