# Development of a technology of innovative microbiologically enriched mineral fertilizers (BIO-FERTIL)

P. Rusek[1], K. Borowik[1], M. Mikos-Szymańska[1], S. Schab[1]

[1] Fertilizer Department, New Chemical Syntheses Institute, Al. Tysiąclecia Państwa Polskiego 13a, 24-110 Puławy, Poland
Keywords: beneficial microorganisms, biofertilizers, humic acids, soil reclamation.
Presenting author email: piotr.rusek@ins.pulawy.pl

Nowadays, a vast number of commercial biofertilizers are available worldwide. However, the quality and efficacy of many of them are not proven or tested. In the absence of efficacious biofertilizers of good and consistent quality, the dependence on the use of mineral fertilizers is not likely to decrease. Thus, the availability of high-quality biofertilizers must be priority particularly in countries where crop plant production plays a key role in the economy and food security (Lesueur et al., 2016). The BIO-FERTIL project aims to reduce the amount of mineral fertilizer input without decreasing yield of crops, by using function of beneficial microorganisms in biofertilizer, which increase availability of plant nutrients from soil.

Modern technologies in intensive crop production, as well as decreasing organic fertilization, lead to degradation of agricultural soils in Poland and other EU countries. Therefore, ecological methods are being sought to increase the level of organic matter and humus in agricultural soils because they determine soil biological activity, increase water and sorption capacity, and improve soil structure. On the other hand, the use of biofertilizers may involve certain risks to the natural environment because the addition of bioproducts can reduce soil microbial activity by binding the nutrients present in the soil. It is expected that the innovative biofertilizers developed under this project do not have these disadvantages. Humic acids will be used as carriers of beneficial microorganisms and other components and the combinations of them increases the rate and effectiveness of their beneficial action on the growth and yield performance of plants. At present, humic acids are gaining popularity and are seen as one of the remedies for the problems associated with the progressive degradation of arable soils. They can be used in crop production (Canellasa et al., 2015), in improvement of soil properties, bioremediation of contaminated soils (degraded lands) (Turgay et al., 2010) and as the additives in the production of organic fertilizers. Humic acids can be extracted from organic waste recycled by composting (Canellas et al., 2002, Baldotto et al., 2016). For the project, humic acids are produced from the fractions of brown coal which are free of harmful substances.

The purpose of the project is to develop the 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. At the first stage of the project, the biofertilizers were produced by combining urea, NPK mineral fertilizers with precisely characterized beneficial microorganisms. At the next stages of the project, the biofertilisers will be manufactured with the use of beneficial microorganisms and natural humic acids.

The project is organized into 6 work packages: WP1 - Production technology of microbiologically enriched fertilizers, WP2 - Effectiveness of biofertilizers in improving bio-physico-chemical properties of degraded and agricultural soils, WP3 - Effect of biofertilizers on growth and yield of horticultural plants and on soil microbiology, WP4 - Effect of biofertilizers on growth and yield of arable crop plants and on improving soil fertility, WP5 - Assessment of the impact of biofertilizer use on water potential and macro- and microelement content in the soil and plants, WP6 - Preparation for implementation, dissemination and commercialization of research results and newly developed biofertilizers.

The BIO-FERTIL Consortium is as follows:

- Research Institute of Horticulture, Skierniewice, Poland (Leader)
- 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

The project has started in February 2018 and is expected to be completed by the end of January 2021 (36 months).

**Conclusions**

The production of biofertilizers by the method of coating the mineral fertilizer granules with an external layer containing a neutral carrier seems to be the most appropriate direction for the production of this type of products. During the production process, it is advantageous to use low temperatures and to avoid using water as much as possible, because in the presence of moisture, especially at elevated temperatures, as during drying, rapid growth

of live bacteria from their spore forms took place. It is also beneficial to physically separate the bacteria from the fertilizer granules, so that they are not exposed to high local concentrations of mineral salts formed during the dissolution of the fertilizer in the soil under the influence of moisture. Diversification of the dissolution rate of both these layers by creating a readily soluble outer coating containing microorganisms may favourably affect the effectiveness of the use of biofertilizers.

In the carried out laboratory tests, the method of incorporation of bacteria into granulated fertilizers was developed by applying the coating in the form of an external layer of bacteria deposited on an organic carrier (carbohydrate) using different binder formulations. The bacterial survival in the manufactured biofertilizer products was about 1 month and was probably reduced by the hygroscopicity of the product. Biofertilizers, due to their hygroscopicity, were sensitive to moisture and lost their microbiological activity when they were stored improperly.

In the further stage of research, the quality of the coatings should be improved by modifying their composition or production method, with particular emphasis on the high survival rate of microorganisms and physical properties of the final products.

Moreover, the biofertilizer application on maize at field trials carried out in 2018 show the positive effects on its production.

**References**

Baldotto, M.A., Rocha, J.E., Andrade, F.D.P., Del Giúdice, M.P, Baldotto, L.E.B.: Plant stimulant humic acid extracted of organic waste recycled by composting combined with liming and fertilization. Semina Ciências Agrárias, 37:3955-3964 (2016)

Canellas, L.P., Olivares, F.L, Okorokova-Façanha, A.L., Façanha, A.R.: Humic Acids Isolated from Earthworm Compost Enhance Root Elongation, Lateral Root Emergence, and Plasma Membrane H+-ATPase Activity in Maize Roots. Plant Physiol. 130(4): 1951–1957 (2002)

Canellas, L.P., Olivares, F.L., Aguiara, N.O., Davey L. Jones, D.L., Nebbioso, A., Mazzei, P., Piccolo, A.: Humic and fulvic acids as biostimulants in horticulture. Scientia Horticulturae 196:15–27 (2015)

Lesuer, D., Deaker, R., Herrmann, L., Brau, L., Jansa, J.: The Production and Potential of Biofertilizers to Improve Crop Yields. In: Naveen, A., Mehnaz, S., Rafaella, B. (Eds.) Bioformulations: for Sustainable Agriculture, pp. 71-92, Springer (2016). DOI: 10.1007/978-81-322-2779-3

Turgay, O.C., Erdogan, E.E., Karaca, A.: Effect of humic deposit (leonardite) on degradation of semi-volatile and heavy hydrocarbons and soil quality in crude-oil-contaminated soil. Environ. Monit. Assess. 170(1-4):45-58 (2010). doi: 10.1007/s10661-009-1213-1

**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.