New generation mineral fertilizers promoted by biologically active additives

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The characteristics of innovative microbiologically enriched fertilizer products which have specific properties in stimulating the growth and yielding of crop plants were presented. The intensive research on development of environmentally friendly techniques for plant cultivation which would optimize fertilization process of cultivated plant has been carried out for many years. One of the fastest-growing and most promising fields of fertilizer industry is the use of fertilizers biologically enriched with additives that is with appropriately selected bacteria or fungi. Bio-fertilizers are the object of research both in the field of their manufacturing technology (Rolewicz et al., 2018) as well as for evaluating their impact on growth and yielding of crop plants, as they can be an alternative to the conventional mineral fertilization. A long lasting and inappropriate use of mineral fertilizers and plant protection products, lack of organic fertilization or inappropriate crop rotation have a negative effect on soil condition and on creating the microorganism population, leading consequently to deterioration of the quality and volume of yields (Derkowska et al., 2015). It is estimated that microorganisms constitute 85% of total biomass of soil organisms and are of key importance for soil fertility by mineralizing organic mass, limiting the growth of pests and pathogens, for formation of humus and lumpy structure of soil, providing appropriate aqueous-air conditions for plant development (Lynch and Bragg, 1985). Soil microorganisms can be classified as autochthonous or zymogenic, which are periodically present in soil and develop after adding easily assimilable organic matter. The autochthonous microflora include *Micrococcus, Bacillus, Enterobacter, Escherichia*, or *Bacterioides* bacteria. Moreover, bacteria which fix atmospheric nitrogen and carry out conversions of mineral nitrogen such as *Azotobacter Serratia, Nitrosomonas, Nitrobacter,* or those which live symbiotically with legume plants: *Rhizobium, Mezorhizobium,* or *Bradyrhizobium* are of great importance.

Bacteria have a positive effect not only on soil environment, but they also stimulate the growth and development of plants directly and indirectly by increasing bioavailability of necessary nutrients. The microbiologically enhanced fertilizers supply micro and macro elements necessary for growth and life activity, whereas the presence of active microorganisms supports mechanism which improves soil fertility. They protect plants, improve and change the quality of soil ensuring the recovery of natural fertility and biological environment.

According to Business Communication Co. Report, the value of global market of microbes and microbiological products was 186.3 billion USD in 2018. This market is developing very rapidly and it is expected to reach the value of approx. 302.4 billion USD in 2023 with the assumed annual growth rate CAGR (Compound Annual Growth Rate) of 10.2% in 2018–2023. The biggest sector encompasses microbiological products (biofertilizers, biopesticides, probiotics) which reached the value of 177.2 billion USD (McWilliams, 2018) in 2018. The largest outlets for such products include the United States of America. Europe and Asia (Abhilash et al., 2016). It is expected to reach 289.7 billion USD in 2023 with CAGR amounting to 10.3% in forecast years (McWilliams, 2018).

In the Łukasiewicz Research Network- New Chemical Syntheses Institute, the grant "Development of innovative technology of microbiologically enriched mineral fertilizers" Acronym BIO-FERTIL BIOSTRATEG3 / 347464/5 / NCBR / 2017 is being implemented. The aim of the project is to develop a technology for the production of innovative microbiologically enriched mineral fertilizers and to evaluate the effects of their application in plant cultivation as well as to evaluate the microbiological stimulation of soil fertility and productivity. The newly developed bio-fertilizers are created by combining simple fertilizers: nitrogen and phosphorus and complex fertilizers (NPK) with carriers and beneficial microorganisms with a biostimulating and protective effect. Specially designed carriers of beneficial microorganisms, devoid of harmful substances, enable the maintenance of high numbers and survival of beneficial microorganisms in bio-fertilizers. Useful microorganisms from the SYMBIO BANK of the Institute of Horticulture in Skierniewice and new species isolated from the rhizosphere of the studied plants were used for the microbiological enrichment of mineral fertilizers. SBL-INS in cooperation with the Institute of Horticulture and Grupa Azoty Zakłady Azotowe "Puławy" S.A. develops a technology for the production of batches of microbiologically enriched fertilizers necessary for field experiments. The batches of microbiologically enriched fertilizers for field trials were produced at INS on a semi-technical scale. The obtained bio-fertilizers were subjected to physico-chemical tests and evaluation of their

qualitative and quantitative composition. The key element is the development of an optimal method of introducing beneficial microorganisms into the formulation of new bio-fertilizers and ensuring high survival of microorganisms during the storage of fertilizers. Fertilizers are produced with the use of CH114AB, AF75BB, CZP4 / 4 microorganisms.

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