Abstract of PhD thesis entitled "Development of environmentally safe methods to stimulate seed germination and plant growth"

Author: Katarzyna Dziergowska

Currently used methods of the stimulation of seeds germination and plant growth apply chemicals that are harmful to the environment. It is therefore necessary to look for new, environmentally friendly approaches. The aim of this PhD thesis was to develop the solutions to increase plant yield by using non-chemical ways of seed germination and plant growth stimulation, including physical factors and bioproducts based on macroalgae biomass (applied both before sowing and during plant growth). A novelty in the thesis is the simultaneous application of products based on macroalgae (extracts and zinc oxide and copper oxide nanoparticles biosynthesized using these extracts), obtained using environmentally friendly technologies and physical factors (static and alternating magnetic field, and ultrasounds) to stimulate seed germination and plant growth. Additionally, a technology for the management of waste macroalgae biomass was proposed (from the raw material – algae biomass, to the product – extracts and the resulting side products – post-extraction residue). The research was conducted on six species of macroalgae from three divisions: green algae – *Cladophora glomerata* and *Enteromorpha* sp., brown algae – *Sargassum* sp. and *Fucus vesiculosus*, and red algae – *Porphyra* sp. and *Palmaria palmata*.

As part of the PhD thesis, a series of tests on plants were carried out (from germination tests, to pot tests and finally field trials) to assess the application potential of pre-sowing stimulation of seeds with physical factors and stimulation of seed germination and plant growth with obtained products based on macroalgae biomass. The conducted research showed the positive effect of static and alternating magnetic field and ultrasounds, extracts from six macroalgae (*C. glomerata*, *Enteromorpha* sp., *Sargassum* sp., F. *vesiculosus*, *Porphyra* sp. and *P. palmata*) produced by ultrasound-assisted extraction and zinc oxide nanoparticles and copper oxide nanoparticles biosynthesized with the use of algal extracts on selected parameters of seed germination and plant growth. Metal oxide nanoparticles and ultrasounds were also used to protect the seeds against the growth of fungi on their surface. The conducted research showed a positive effect of simultaneous seed stimulation with a physical factor and algal extract on seed germination and selected plant growth parameters compared to the control group and groups stimulated with these factors individually. Moreover, in the PhD thesis, the efficiency of macroalgae and post-extraction residues from macroalgae as biosorbents of heavy metal ions from aqueous solutions was proved.

The presented PhD thesis is interdisciplinary – it combines three scientific disciplines – chemical engineering, mechanical engineering and agriculture and horticulture. The research was conducted in a full research cycle – from preliminary research (selection of parameters of physical factors for seed stimulation; production and characterization of products based on macroalgae), to the analysis of functional properties – tests on selected plant species.