

Currently there is a need to search for novel chemical compounds with targeted properties. Ionic liquids (ILs) are an example of such compounds and their synthesis perfectly fits the principles of green chemistry. The aim of the project is to obtain new ionic liquids (ILs) of natural origin which will act as auxins (plant hormones which stimulate their growth and development). Apart from cations which are derivatives of choline, betaine and quinine (compounds which exhibit biological activity) the studies will include anions comprising plant hormones in their structure – e.g. indole-3-acetic acid (IAA) along with its derivatives (IBA and IPA). The project assumes the synthesis of ILs which will be more efficient in terms of interactions with plants, be readily biodegradable and, most importantly, will not influence the natural microbial communities of the plant root system and the plant immune system, thus increasing its resistance to stress associated with draught. In case of numerous plants the natural auxins (plant hormones which stimulate their growth and development) act more efficiently in promoting the root growth compared to their synthetic counterparts. Synthetic auxins (e.g. derivatives of phenoxyacids: 2,4-D; MCPA) are used as herbicides for elimination of weed, however their common use negatively impacts the widely understood process of gaining resistance to plant protection agents, which is a significant issue in agriculture. The use of natural auxins in the form of ionic liquids should eliminate the issue of widespread resistance to herbicide. By using such substances, the plants will not be subjected to external stress factors in the form of synthetic auxins and will not be forced to initiate defensive mechanisms.

During the studies it is planned to synthesize, purify and identify ionic liquids of natural origin comprising IAA and tryptophan derivatives. Furthermore, basic physicochemical parameters of such compounds (density, viscosity, refraction index, solubility and thermal stability) as well as surface and biological activity (against model microorganisms, crops and weed resistant to herbicides) will be determined. The transport through membranes and biodegradation of biologically active ILs comprising IAA will also be evaluated. Moreover, field experiments in agricultural fields will be conducted for selected compounds. Additionally, the qualitative and quantitative changes in microbial populations inhabiting the root area of plants (rhizosphere) will also be assessed. Finally, the correlation between the chemical structure, properties and biological activity of the synthesized ILs will be established.

The proposed project is novel, since the studies conducted to date did not include ionic liquids of natural origin based on natural plant hormones such as auxins. This research topic is significant for the agriculture, as currently there is an ongoing search for novel chemical compounds which may stimulate the growth of crops and simultaneously exhibit no negative effects on the soil environment. Therefore readily biodegradable compounds with a marginal influence on soil microbial communities are desirable. This especially applies to the rhizosphere, which plays a fundamental role in proper plant development due to various interactions between plants and microorganisms. As a result of numerous elements of novelty, the project will contribute to the improvement of the international position of Polish chemistry in the field of ionic liquids, particularly in the aspect of plant protection agents.