Research project objectives

Continuous growth of the human population is a main factor contributing to increase in the demand for food, which forces farmers to use more effective methods of growing crops. Serious threats to crop yields are pathogens, insects or other pests and atmospheric conditions. These factors pose a challenge to modern agronomists in searching for new and effective methods to protect plants. The biggest unsolved problem in agriculture are viral diseases. At present, there are no chemical methods with the ability to inhibit the spread of viral diseases, and because of that, viruses cause every year huge losses in plant production worldwide. Induction of plant resistance against pathogens is a very promising and environmentally friendly method of plant protection. However, applying a resistance stimulant may significantly disturb plants energy management, what can impact on its growth, crop yield or even lead to phytotoxic reaction.. Therefore, it is reasonable to create bifunctional salts combined with anti-stress cation and SAR inducer anion and examine their ability to enhance resistance in plants to abiotic and biotic stress. Moreover addition of anti-stress agent can decrease adverse effect of SAR inducer on plant growth and yielding.

Project objective is the examination of the anti-stress effect resulting from combination of cations of poliamines or cholinum-based derivatives as a counterion in a bifunctional salt with the anion of one of the proposed plant resistance inducers to minimize adverse impact of effective dose of SAR elicitors affecting on abiotic stresses on plant growth and its yielding. The obtained results will help in the future in defining a safe, and effective strategy of applying the plant resistance inducer.

The **research hypothesis** assumes that the presence of a cationic poliamines and cholinum-based derivatives will show a beneficial effect on the biological effectiveness of the plant resistance inducers, such as decreasing the phytotoxic effect of inducer or enhancing plant resistance to abiotic stress, what will effect on further development and growth as well as yield of the plant. Confirmation of this hypothesis will allow: i) to determine the correlation between used cationic anti-stress agent and the biological activity of its salts, ii) determine the impact of the presence of anti-stress agent and resistance inductor on plant growth and yielding, iii) the ability to develop an effective strategy of using plant induction in the future.

Methodology of research

The project will be implemented in four stages: 1) Design and synthesis of new bifunctional salts consist of poliamines or cholinum derivative cation and anion of systemic acquired inducer and examination of physicochemical properties of the synthesized compounds, 2) Investigation of SAR inducing properties of new bifunctional salts, 3) Examination of the impact of presence of anti-stress agent combined with SAR inducers on the phytotoxic effect of resulted salt, and 4) Examination of the impact of presence of anti-stress agent combined with SAR inducers on enhancement of plant resistance to other biotic and abiotic stresses. First, plant inducers such as 2,6-dichloroisonicotinic acid, pipecolic acid, salicylic acid or β-aminobutyric acid will be deprotonated into ionic form, paired with a simple inorganic cation, eg. potassium. Next, an ion exchange will be performed, where the base cation will be converted to a polyamine cation such as spermidine and spermine or cholinum-based cation such as betaine and chlorocholine which will result in formation of bifunctional salt. In the second stage of the research resulting compounds will be tested for their biological activity, e.g. the induction of resistance in a Tobacco infected by TMV virus. In third stage it will be examined the impact of presence of anti-stress agent combined with SAR inducers on the phytotoxic effect of tested salt. In fourth stage, impact of presence of anti-stress agent combined with SAR inducers on enhancement of plant resistance to biotic and abiotic stresses will be tested using qPCR method.

Justification for tackling specific scientific problems by the proposed project

Plant resistance inducers seem to be a promising group of plant protection products, especially in view of the new challenges posed to agriculture by the European Union. At present, the biological effectiveness of these compounds has already been confirmed in terms of prevention of viral, fungal and even bacterial diseases. However, there are studies which shows adverse impact of using these substances on plant growth or yielding. The realization of this project will allow to gain knowledge about the minimalize of adverse impact of the inductor on further growth and yielding of plants. Obtained information will allow to aware application of resistance inducers to the plant, which will minimize the risk of lowering crop yield. The research described in this project is necessary in understanding the role of poliamines and compounds based on cholinum structure in decreasing phytotoxic effect of SAR inducers and an indication of the direction of research on the optimization of the methods of application of new compounds with the character of plant immune inducers. Probably, the observed correlations will also be applicable to other plant protection products such as systemic fungicides, which may have a positive influence on the development of other types of agrochemicals.