Abstract

For many years, Poland has been a leader in apple production in the EU (4 million tons in 2021) and invariably holds third place in the world after the USA and China. Currently, among fruit growers from European countries (including Poland), surveyed in terms of their needs related to apple cultivation, the issues related to disease and pest control are the most difficult for them. Troublesome and difficult to deal with apple diseases are: fire blight caused by the bacteria *Erwinia amylovora* and fungal diseases: apple scab (*Venturia inaequalis*) and powdery mildew (*Podosphaera leucotricha*).
Fire blight is a systemic disease, so when the bacteria penetrate inside the plant, there is no way to limit or inactivate them. In turn, combating apple scab and powdery mildew requires a very large number of treatments with chemical agents (about 25 per season). As a result, the apple tree is an orchard crop that consumes the most pesticides. This leads to the risk of pesticide residues in consumed fruit and environmental pollution.
Copper preparations are the basis of fire blight control and an important element in the control of apple scab. However, they have numerous limitations, the most important of which is the only surface effect. These preparations are additionally only bacteriostatic against *E. amylovora*. Currently, there is a tendency to limit the use of preparations from this group due to, e.g. environmental toxicity. Growers who perform treatments with copper compounds are able to contaminate the soil with this element in a similar way to heavy industry. In addition, copper inactivates pollen, which may reduce the yield and be of great importance, especially in the era of pollinator deficiency, for which copper is also toxic. Regardless of the above-mentioned disadvantages, copper preparations remain the only group of effective bacteriostatic agents against *E. amylovora*. It is possible that in the near future there will be some restrictions on their use, and even a complete ban on applications. New "surface substitutes" in the fight against this disease will always be ineffective due to the nature of the pathogen (systemic spread). This can lead to a serious gap in the protection program of this serious apple disease.
An alternative to chemical protection measures may be the induction of plant resistance, which consists in the temporary creation of barriers limiting or preventing the development of diseases. From the so far known inducers of resistance to fire blight, the literature (including the newest) mention e.g. preparation of Bion® (BTH) and Regalis 10 WG (prohexadione of calcium). However, there are no studies of new and more effective inducers against this disease. In turn, there is a very narrow known group of chemicals that can induce resistance to fungal diseases such as apple scab or powdery mildew in apple. The aim of the research planned in the project is to synthesize new chemical compounds with potential properties of inducers of plant resistance to pathogens and to test their protective effect on apple trees against its most important diseases (fire blight, apple scab, and powdery mildew). Our goal will also be to determine the mechanism of action of the tested compounds on the global change of apple gene transcription using the second-generation sequencing method (RNA-seq) as well as phytohormonal profiles. Such work (based on RNA-seq) has not been carried out so far. It is also planned to perform analyzes of the activity of selected enzymatic markers in apple tissues, responsible for plant defense reactions, after treatment with new inducers.
The analysis of the influence of inducers on the apple tree will also be carried out at the level of research on structural changes in tissues treated with selected substances. At the same time, we will determine how new chemical compounds affect selected environmental factors, including the viability of the honey bee, an important pollinator.
The research outlined in the project will have the benefit of synthesizing new inducers that could pave the way for other research (on their properties) and even find practical applications in the future in protecting apple orchards against disease. Project research results have the potential to reduce orchard chemicals and replace some harmful substances with more environmentally and human-friendly conditions.