Abstract

As sessile organisms, plants cannot avoid being exposed to various biotic and abiotic stress factors. To defend themselves plants have developed complex and sophisticated defense mechanisms. In agriculture, pesticides are used for plant protection, but they can have undesirable side effects, and therefore attention is being paid to biological control agents.

One such agent is *Pythium oligandrum*, a soil oomycete that has a positive effect on plants at several levels. On the one hand, it secretes elicitins, which stimulate defensive responses and prepare the plant for possible infection (i.e., priming effect), and on the other hand, it produces tryptamine, a precursor of auxin, thus supporting the plant's growth. Furthermore, *P. oligandrum* directly acts as pathogen mycoparasite or evokes antibiosis, or competition for nutrients and space with other microorganisms.

The key research topic of this thesis was the analysis of the biochemical properties of eleven *Pythium* strains and their impact on plant metabolism. Our results showed that even closely related *P. oligandrum* strains significantly differ in the content of compounds secreted into the medium, including proteins, amino acids, tryptamine, and hydrolytic enzymes capable of degrading cell walls (endo-ß-1,3-glucanase, chitinase, and cellulase), exoglycosidases, proteases, and phosphatases. Rapeseed plants, seed-coated with *Pythium* strains, showed major differences in the phytohormone levels, i.e., increased concentrations of auxin and jasmonates (and salicylic acid in some strains), indicating plant growth promotion as well as readiness for effective defense response. The *Pythium* strains treated plants showed increased activities of isoforms of superoxide dismutase and peroxidase, involved in the plant antioxidant system, as well as shikimate dehydrogenase, one of the key enzymes in the secondary metabolite synthesis. The different behavior or "life strategy" of the *Pythium* strains may be crucial for selecting advantageous biological control agents.

Plant viruses are responsible for considerable economic losses. Various factors affect the virus propagation and plant defense responses. We followed the effect of two-hour long heat shock of 42°C on the course of potyviral (PVY^{NTN}) infection in *Nicotiana tabacum*. Heat shock protein (Hsp) expression plays an ambiguous role in viral infection. Hsp70 participates in plant defense response but also can interact with viral proteins and facilitate virus propagation. We detected that Hsp70 accelerated potyviral propagation in tobacco plants. The cytosolic and mitochondrial Hsp70 (~50-75 kDa) were present during the developed viral infection. Also, the plant defense response to PVY^{NTN} included an increase of salicylic and chlorogenic acids but decrease of quinic acid content. We also summarized the current scientific research about the mutual behavior of Hsp70 and viral infection in a review.

The plant protection still relies on the use of pesticides which represent a potential threat to the non-target organisms. The mechanism of triazole action lies in blocking the fungal sterol 14-α-demethylase (cytochrome P450 51A1), resulting in the depletion of ergosterol, and thus destabilization of the fungal plasma membrane. We observed that the foliar treatment by triazoles (fungicides) and their mixtures likely induces oxidative stress in tomato plants, resulting in alteration of some phenolic compound contents such as quercetin, *p*-coumaric acid,

and hesperidin in fruit. We studied the interactions of triazoles mixtures in the presence of copper and zinc cations that significantly change the compound reactivity. The triazole cocktails also showed a significant inhibition impact on the enzymes of the non-target organisms, such as cytochromes P450 19A1 (aromatase) and 3A4 that can cause significant health problems for humans and animals.

Herbicides like glyphosate target the shikimate pathway, which represents a metabolic route for the biosynthesis of aromatic amino acids and a connection to the production of various phenolics. We studied the mechanism of bisubstrate reaction and side reactions of the shikimate dehydrogenase from the root of *Petroselinum crispum*. We observed a feed-back regulation for one branch of phenylpropanoids on the shikimate dehydrogenase activity and that the compounds with higher number of hydroxyl groups showed higher inhibition impact.

Phenolics are undoubtedly the largest group of natural substances with antioxidant properties. We analyzed commonly available herbs in the form of teas and tinctures, with *Agrimonia eupatoria* showing the highest total phenolics content, also *Origanum vulgare* and *Mentha* × *piperita* possessing high antioxidant capacity in aqueous extracts.

Keywords: *Pythium oligandrum*, biological control agents, antioxidant system, phenolic compounds, viral infection, heat shock proteins, triazoles, fungicides.