Biotechnology of microorganisms, Phytopathology and Entomology

I. Research Group

The research group of **Biotechnology of microorganisms, Phytopathology and Entomology** is comprised of two teams of specialists focused on issues related to microorganisms and pests. They form the Department of Entomology and Molecular Phytopathology of the Faculty of Agriculture and Biotechnology.

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Department of Entomology and Molecular Phytopathology
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II. Group's Leader

Dariusz Pańka – Head of the Department of Entomology and Molecular Phytopathology
Born in 1970, working in research since 1992.

1993 - graduation from the studies and being awarded the degree of MSc in eng. in agriculture, specialising in plant protection, UTP University of Science and Technology in Bydgoszcz. Diploma thesis topic: 'Effect of seed dressing with hyperparasites and selected fungicides on faba bean health status'

1999 – Ph.D. dissertation topic: 'Variation in the pathogenic properties in *Fusarium solani* (Mart.) Sacc. fungus'

2006 – Post-doc at the University of Arkansas, USA in group of professor Chuck West (endophytes of grasses)

2011 - Professional Training Program 'TOP 500 Innovators, Science-Management-Commercialization' – 1st edition, (Course No. XEXE112-001) organized by Ministry of Science and Higher Education in Poland. Stanford University, California, USA.

2013 – Habilitation in the area of symbiotic fungi. Title of the achievement: 'Studies of endophytes representing genera *Neotyphodium* and *Epichloë* as well as their application potential for the protection of grasses from fungal pathogens'

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III. Group's Members and Research Interests

- Dariusz Pańka (grass endophytes, biochemistry and physiology of plant stress, plant resistance patterns, endosymbiotic microorganisms, biological control, testing of fungicides efficacy for chemical companies, use of low-temperature plasma (DBD Plasma))
- Dariusz Piesik (Volatile organic compounds released by plants under stresses, entomology)
- Grzegorz Lemańczyk (monitoring of occurrence of pathogens causing eyespot, biochemistry and physiology of plant stress, plant resistance patterns, testing of fungicides efficacy for chemical companies)

- Robert Lamparski (Volatile organic compounds released by plants under stresses, entomology)
- Leszek Lenc (plant health depending on the environment, potential mycotoxigenic abilities of *Fusarium* spp.)
- Anna Baturo-Cieśniewska (molecular studies of fungi, potential mycotoxigenic abilities of *Fusarium* spp., Contamination of harvested grain with mycotoxin-producing fungal species)
- Małgorzata Jeske (grass endophytes, biochemistry and physiology of plant stress, plant resistance patterns, endosymbiotic microorganisms, biological control, use of low-temperature plasma (DBD Plasma))
- Aleksander Łukanowski (molecular studies of fungi, potential mycotoxigenic abilities of *Fusarium* spp., Contamination of harvested grain with mycotoxin-producing fungal species)
- Karol Lisiecki – Ph.D. student (grass endophytes, biochemistry and physiology of plant stress, plant resistance patterns, endosymbiotic microorganisms, biological control)
- Katarzyna Koczwara – Ph.D. student (grass endophytes, biochemistry and physiology of plant stress, plant resistance patterns, endosymbiotic microorganisms, biological control)
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IV. Leading Research Topics of the Group

In general our group is interested in the following subjects: biochemistry and physiology of plant stress, plant resistance patterns, biology, epidemiology and signaling of fungal pathogens of crops, molecular studies of fungi, potential mycotoxigenic abilities of *Fusarium* spp., occurrence and role of endophytic fungi from genera Neotyphodium and Epichloë inhabiting various species of grasses, monitoring of occurrence of pathogens causing eyespot, induction of plant's resistance, use of low-temperature plasma (DBD Plasma) in the protection of plant products and food against microorganisms

V. Description of Main Research Topic

Biochemistry and physiology of plant stress, plant resistance patterns

In our research we are interested in plant response patterns to exposition to abiotic and biotic stress, and searching for a defense mechanisms (for example in winter wheat, barley, grass plants), which could be a valuable information for developing resistant lines/cultivars. These mechanisms are studied on the basis of defense markers development during the exposition and in plant signal transduction. For the plant stress resistance we evaluate the development and activity of some pathogenesis-related proteins (PR) such as glucanase and chitinase family enzymes, cell wall strengthening enzymes (Phenylalanine/tyrosine ammonia-lyase), oxidative burst enzymes (for example peroxidase, ascorbate peroxidase, catalase, SOD,GSH and more), plant secondary metabolites and signaling molecules formation and distribution in plant tissues, lipid peroxidation, proline concentration.

Symbiotic microorganisms

The occurrence of endomycorrhizal (*Rhizophagus* spp.) and endophytic microorganisms (especially grass endophytes – *Epichloe* spp.) is resulting in increased plant resistance, but the exact mechanisms are yet not fully known. In our team we are trying to find,

indentify and use such microorganisms to enhance plant stress resistance during exposure to all kind of stresses (both biotic and abiotic).

Plant health depending on the environment

Our team conducts studies on effect of cropping system (organic, conventional, integrated and monoculture) on the health of crops (mainly cereals). These analyzes concern an assessment of occurrence of the most important plant pathogenic fungi during growing season and on harvested grain. We focus on the method of application of substances containing beneficial microorganisms in the storage, their development on stored products and their limitation effect on pathogens. We identify plant pathogenic fungi in PCR assay basing on the sequence of ITS regions and blast with data in gene bank. In this way we get information on the different species inhabiting different environments

Contamination of harvested grain with mycotoxin-producing fungal species

Analyses concern mainly detection of presence of *Fusarium* species in raw plant material, harvested grain and in the soil. Qualitative and quantitative molecular techniques (PCR and qPCR) enable to determine the level of settlement plant material with fungi which is important from a nutritional point of view, since it allows to determine the potential risk of contamination with secondary metabolites of fungi. basing on the sequence of ITS regions and blast with data in gene bank. In this way we get information on the different species inhabiting different environments

In addition, the measurement of settlement of plant material enables the assessment of the effectiveness of the agricultural treatments, fungicide and their doses applications and verification of plant cultivar susceptibility to infection by the pathogen.

Mycotoxigenic potential of fungi

Molecular technique (PCR assay) is used for research on potential mycotoxigenic abilities of some fungi (mainly representing genus *Fusarium*) to synthetize specific groups of mycotoxins and their derivatives (chemotyping). It is conducted by analysis of the presence of specific genes coding enzymes engaged into pathway of mycotoxin biosynthesis. The results of molecular analyzes in this area allow to pre-determine the type of dominating toxins during growing season in the area of cultivation, and thus also indirectly determine the degree of risk of contamination of grain and other vegetable products with these metabolites.

Pathogens in commercial production of ornamental plants

Bacterial and fungal pathogens eg. *Xanthomonas campestris*, *Rhodococcus fascians* or *Thielaviopsis basicola* can be problematic in the production of propagation material of ornamental plants. They cause the diseases of older plants and economic losses for producers.

We focus on molecular identification of pathogens on symptomatic and also on asymptomatic plants. Asymptomatic plants infected with bacteria or fungi can contribute to the spread of pathogens with seedlings in glasshouses, between farms and gardens, within small and extensive areas and result in spread of pathogen. They are especially dangerous in *in vitro* production. Early and precise identification of pathogens enables you to take treatments limiting the development of pathogen.

VI. General Expression of Interests

Due to European Union regulations (Regulation (EC) No 1107/2009, Directive 2009/128/EC) all of the member countries are obligated to use integrated pest

management and the interest in biological plant protection is rising. There is great need for searching for natural sources of plant resistance – both inside the plant and in symbiotic systems it is created. For practical use, better understanding of plant reactions is needed. That is why our general interests are focused on understanding the defense mechanisms in plants (especially cereals and grasses) against various phytopathogens. We are interested in plant biochemistry during infection, signal transmission inside plant and overall plant signaling as well as molecular studies of fungi, and research on volatile organic compounds and their role in the interaction plant-symbiont-pathogen-pest.

VII. Other research activities

We started research on nodulation bacteria (*Bradyrhizobium japonicum* on soybean). We analyze the effect of different agronomic conditions such as fertilization and cropping system on the development of *B. japonicum* in qPCR assay.
Other new field of our research is DBD plasma. The use of low-temperature plasma in the protection of plant products and food against microorganisms is an area of our interest.

VIII. Main Group's achievements

It has been proven that *Epichloe festucae* var. *lolii* can significantly increase the content of phenolic compounds in perennial ryegrass, which is most probably one of the major mechanisms of a higher resistance of plants E+ to the infection and development of the disease process; moreover, endophyte presence can significantly increase the emissions of organic volatile compounds in perennial ryegrass, which can affect the induction of specific resistance mechanisms in plant E+ attacked by the pathogen as well as it is responsible for inducing the defense reaction in the neighboring plants.

Chosen publications

Baturo-Ciesniewska A., Andrzejewska J., Albrecht K., Sadowski Cz., Lenc L., 2013. First Report of Sclerotinia Stem Blight Caused by *Sclerotinia trifoliorum* on *Trifolium ambiguum* in Poland. Plant Disease 97:142.

Baturo-Ciesniewska A., Grabowski A., Panka D., 2012. Diversity in the Polish isolates of *Drechslera teres* in spring barley as determined through morphological features, mating types, reaction to control agents and RAPD markers. Journal of Plant Pathology 94 (2): 339-351.

Baturo-Ciesniewska A., Lenc L., Grabowski A., Lukanowski A., 2015. Characteristics of Polish isolates of *Fusarium sambucinum*: molecular identification, pathogenicity, diversity and reaction to control agents. American Journal of Potato Research 92:49–61. (Online VII 2014 - DOI: 10.1007/s12230-014-9410-z)

Baturo-Ciesniewska A., Suchorzyńska M., 2011. Verification of the effectiveness of SCAR (sequence characterized amplified region) primers for the identification of Polish strains of *Fusarium culmorum* and their potential ability to produce B-trichothecenes and zearalenone. International Journal of Food Microbiology 148 (3): 168-176.

Delaney K.J., Breza-Boruta B., Lemańczyk G., Bocianowski J., Wrzesińska D., Kalka I., Piesik D., 2015. Maize VOC induction after infection by the bacterial pathogen,

Pantoea ananatis, alters neighbouring plant VOC emissions. Journal of Plant Diseases and Protection 122 (3): 125-132.

Delaney K.J., Wawrzyniak M., Lemańczyk G., Wrzesińska D., Piesik D., 2013. Synthetic cis-jasmone exposure induces wheat and barley volatiles that repel the pest cereal leaf beetle, *Oulema melanopus* L. Journal of Chemical Ecology 39 (5): 620-629.

Grabowski A., Siuda R., Lenc L., Jaroszuk-Ściseł J., 2012. Effect of the degree of fusariosis on the physical characteristics of individual wheat kernels. Int. J. Food Sci. Tech. 47: 1122–1129.

Lemańczyk G. 2011. Use of SCAR-PCR in diagnostics of stem base pathogens of the *Rhizoctonia* and *Oculimacula* genus. Acta Agrobotanica 64 (4): 197–206.

Lemańczyk G., Kwaśna H., 2013. Effects of sharp eyespot (*Rhizoctonia cerealis*) on yield and grain quality of winter wheat. European Journal of Plant Pathology 135 (1): 187-200.

Lenc L., Kwaśna H., Sadowski Cz., 2012. Microbial Communities in Potato Roots and Soil in Organic and Integrated Production Systems Compared by the Plate Culturing Method. J. Phytopathol. 160: 337-345.

Lenc L., Kwaśna H., Sadowski, C., Grabowski A., 2015. Microbiota in Wheat Roots, Rhizosphere and Soil in Crops Grown in Organic and Other Production Systems. J. Phytopathol. 163 (4): 245-263.

Pańka D., Piesik D., Jeske M., Baturo-Cieśniewska A., 2013. Production of phenolics and the emission of volatile organic compounds by perennial ryegrass (*Lolium perenne L.*)/*Neotyphodium lolii* association as a response to infection by *Fusarium poae*. Journal of Plant Physiology 170: 1010 - 1019.

Pańka D., West C.P., Guerber C.A., Richardson M.D. 2013. Susceptibility of tall fescue to Rhizoctonia zeae infection as affected by endophyte symbiosis. Annals of Applied Biology 163: 257–268

Wiewióra B., Żurek G., Pańka D., 2015. Is the vertical transmission of Neotyphodium lolii in perennial ryegrass the only possible way to the spread of endophytes? PLoS ONE 10(2): doi:10.1371/journal.pone.0117231

Piesik D., Miler N., Lemańczyk G., Bocianowski J., Buszewski B., 2015. *Botrytis cinerea* infection in three cultivars of chrysanthemum in 'Alchimist' and its mutants: Volatile induction of pathogen-infected plants. Scientia Horticulturae 193: 127-135.

Wenda-Piesik A., Lemańczyk G., Pańka D., Piesik D., 2016. Risk assessment posed by diseases in context of integrated management of wheat. Journal of Plant Diseases and Protection 123 (1): 3-18.