

CROP MANAGEMENT

Social and political demand for low risk plant protection methods force integration of research and development activities between academia disciplines

The rapid increase in the demand by societies led by many non-governmental organisations (NGOs – representing consumers and ecological groups) for high quality but safe agricultural products and environmental and human health had to have a strong impact on the political decisions made by the European Parliament. Indeed, the Parliament and Council's Directive 2009/128/EC, in particular Article 14 concerning the Integrated Pest Management (IPM) development and obligatory implementation by farmers since January 2014, is a perfect example of this. IPM is a key component of sustainable farming with the objective to produce healthy crops.

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It is based on an understanding of ecology and the integration between crops and their pests (including pathogens and weeds), as well an understanding of the environment in which the antagonistic organisms operate. It should be considered as an approach based on interdisciplinary collaboration between agronomists, plant geneticists and breeders, plant protection specialists, economists and sociologists.

Public demand

The Faculty of Horticulture, Biotechnology and Landscape Architecture of Warsaw University of Life Sciences – SGGW (WULS-SGGW) believed that the integrated crop management based on IPM may link the public demand for better quality products with guaranteeing the economic sustainability of farmers. They focused their efforts on vegetable and fruit crops where international and national data confirmed an often unjustified overuse of pesticide in high input production systems in order to guarantee high yields and quality of products. These practices led to direct farmer and public health risks, destruction of natural enemies of pests and emergence of secondary pests, development of pesticide resistance, increasing soil and water contamination and other environmental liabilities.

Consequently, the Warsaw Plant Health Initiative (WPHI) project was designed to enhance both the research and networking capacity of academia. The Warsaw Plant Health Cluster (WHPC) is the expansion of the WPHI by breaking traditional administrative ‘walls’ and involvement of academic experts from other departments as well the other WULS-SGGW faculties (e.g. Faculty of Agriculture and Biology, Faculty of Wood Technology) and research institutes located in the vicinity of Warsaw.

This attitude complies with the overarching objectives of European research policy – aimed at enhancing the mobility of researchers, and the dissemination of knowledge and technology within the single EU market for research and innovation. In order to achieve diverse goals and organise the large number of participating members, the project has been divided into six groups called Work Packages. Each group focuses on a particular aspect of plant health research with five key areas being covered, including entomology, plant pathology, crop production, plant-micro-organisms interactions, and functional genomics, as well as creating institutional environment for conducting research projects.

Special attention was paid to ensure that they would encourage internal cross-disciplinary interactions among WPHC research teams, fill the competence gaps, open new avenues for research and international co-operation, and thus improve the research focus and impact of the participating research groups. Project objectives are realised through staff exchange and participation in the international and national conferences, meetings and workshops as well as upgrading existing laboratories and creating new ones, hiring excellent researchers and organising mini-symposia and workshops. In 2013, 11 international mini-symposia and workshops were organised and two new laboratories were established (Laboratory for micro & nano-encapsulation of semiochemicals and Bioinformatics Centre).

The improvements in laboratory standards and scientific expertise of its research staff creates new and challenging opportunities to consider the WPHI research groups as the potential partners in the future Horizon 2020 projects in field of entomology, plant pathology, crop production, plants-micro-organisms interactions, and functional genomics.

The research groups

The Entomology Research Group comprises three research teams: the Functional Biodiversity Team led by ZT Dabrowski, the Ethology Team led by S Lux and the Plant Resistance to Pest

Attack Team led by M Kielkiewicz-Szaniawska. This group is able to collaborate in research in the following areas:

- Biochemical and physiological bases of induced plant resistance to pests and its role in the tritrophic relations: plant – herbivore – carnivore.
- Chemical identification of semiochemicals of plant origin and their use in IPM of selected crops;
- Development of methodology of Environmental Risk Assessment of new traits, for example genetically modified poplar trees;
- Development of monitoring techniques and models on the occurrence of new invasive (alien) species of pests and pathogens; and
- Exploring the Polish sustainable agriculture in search of a benchmark for biodiversity management in intensive agricultural systems.

The Plant Pathology Research Group, led by W Wakulinski, consists of two teams: mycological and virological. It is focused primarily on classical and molecular approaches in plant pathogen detection, taxonomy, phylogenetic relation among species and disease epidemiology. The close and stable collaboration of mycologists with researchers of related scientific branches (genetics, breeders and chemists) is a strong motivation for extending and undertaking work in area of:

- Population genetics oriented on occurrence, distribution and variability of fungal sex genes;
- Association mapping for elaboration of molecular markers for effective selection of ray materials (*Secale cereale* L.) with enhanced resistance to disease; and
- Mutual interaction among species of phyllosphere communities with emphasis on nonculturable, slow growing and/or low competitive microbiota.

The Crop Production Research Group led by M. Gajewski is able to collaborate in research with potential partners in several areas, which relate to plant health problems. Its studies are focused mainly on:

- Vegetable and medicinal plants quality and biological value in relation to plant health during vegetation and postharvest;
- Bioactive natural plant compounds and biostimulators as agents in integrated production of vegetables;
- Methods of postharvest treatments and their influence on health of horticultural crops;
- Introduction to growing practice innovative plants and their use as a potential source of bioactive compounds; and
- Stresses in greenhouse production of vegetable crops.

The Plant-Micro-organisms Interactions Research Group, led by H Gawronska, is focused on developing holistic, pro-ecological systems of crop cultivation, protection and plants coping with unfavorable growth conditions. To meet this challenge an

interdisciplinary approach is used, including microbiology and plant sciences with three major areas of research:

- Increasing plant health via improvement of environment quality by understanding of the mechanisms between plants and micro-organisms involved in combatting with contaminated environment, and working and make it more friendly for plant growth but also the use of plants together with micro-organisms in improving the environment and cleaning it up in order to make it more secure for less tolerant plant species and human beings;
- Monitoring, whole-plant bioassays and molecular analysis of weed resistance, especially to ALS inhibitors in major weeds in Poland: *Apera spica-venti*, *Avena fatua* and soon *Alopecurus myosuroides*. In the near future, within the Horizon 2020 programme, this group is planning to be involved in studies on metabolic type of weeds resistance to herbicides; and
- Physiological, biochemical and molecular mode of action of biostimulants applied for vital processes stimulation and/or protection against stressors.

The Functional Genomics Research Group is composed of the Plant Physiomics Team led by S Karpinski and the Plant-Nematode Interactions Team led by M Filipecki and they are supported by the Bioinformatics Centre, which spreads its expertise to many research groups. The group concentrates on plant reaction to environmental stimuli as well as those deriving from plant pests and pathogens with a vision to develop the applicable abiotic and biotic stress resistance in crop plants such as tomato, potato and poplar.

The plant disease immune system is extensively interlinked with mechanisms of environmental stress reactions as well as metabolic and developmental process. Reactive oxygen and nitrogen species as well as phytohormones play a key role in achieving the homeostasis of plant cell in the environment. The group is attempting to gain the system level of understanding of plant reaction to environment. More specifically, the Plant Physiomics Team is focused on cellular and quantum-molecular mechanisms that regulate redox and hormonal chloroplast-nucleus retrograde signals for light acclimation and immune defenses. Plant-Nematode Interaction Team concentrates on identification of the mechanisms how nematodes change the morphogenetic and molecular programme of selected host root cells to build the feeding structure and how they suppress the plant defense.



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