

## Conclusions and perspectives

### Perspectives for future research-and-development projects on biological control of plant pests and diseases

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The review of published scientific literature on the biological control of selected pests and diseases has led to the identification of clear knowledge gaps highlighted in previous chapters. Further bottlenecks were revealed by seeking the possible reasons for the striking discrepancy between the rich inventory of potential biocontrol agents described by scientists and a very small number of commercial products on the market.

To complement these analyses, the participants of Research Activity 4.3 of the European Network ENDURE organized consultations of experts (scientists, extension specialists and representatives of the Biocontrol industry) at the occasion of scientific meetings of three Working Groups of IOBC-wprs.

- Working Group "Integrated Control of Plant Pathogens": meeting on "Molecular Tools for Understanding and Improving Biocontrol" in Interlaken (Switzerland) September 9-12, 2008. (attended by P.C. Nicot and B. Blum – discussion session about the outlook on biocontrol against plant diseases)
- Working Group "Multitrophic Interactions in Soil" meeting in Uppsala (Sweden), 10-13 June 2009. (attended by C. Alabouvette – roundtable about the outlook on biocontrol of soilborne pests and diseases)
- Working Group "Insect Pathogens and Insect Parasitic Nematodes": meeting on "Future Research and Development in the Use of Microbial Agents and Nematodes for Biological Insect Control" in Pamplona (Spain), 22-25 June, 2009 (attended by C. Alabouvette – his plenary presentations about the outlook on biocontrol of diseases and pests has been published\*).

These consultations were further complemented by discussions at the occasion of various meetings of participants of Research Activity 4.3 to identify the most prominent issues that could be tackled by future research and development activities. The key elements are organised below in three categories, based on their relevance to the concern of the research community, development or industry.

#### Research issues

Five key issues have been identified in term of research needs:

**Devise better strategies for the screening of biocontrol agents.** The demand for new biocontrol agents is already high. It is expected to increase sharply in the EU, with the ongoing

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\* Alabouvette, C, Cordier, C. 2009 Biological control of plant diseases: Future research goals to make it successful. IOBC/WPRS Bulletin 45:3-5.

reduction of available chemical pesticides and the need for new non-chemical plant protection tools to comply with Directive 2009/128/EC. Current methods need to be improved both in terms of logistics (high throughput to allow rapid mass screening of large numbers of candidates) and in terms of the pertinence of criteria for efficacy, production and commercialization. This topic has been tackled within Research Activity 4.3 of the European Network ENDURE for microbial biocontrol agents against diseases (Deliverable DR4.9) and the results have been published (Köhl *et al.*, 2011<sup>\*</sup>).

**Improve knowledge on efficacy-related issues.** The criteria traditionally used to assess the efficacy of biological control methods may be misleading because contrarily to conventional pesticides, biocontrol does not intend to eradicate pests and diseases but, rather, to install a biological balance which will enable the plants to grow more healthily. However the consistency of field efficacy remains one of the constraints for the large scale use of biological control of plant diseases. Despite much recent progress, research efforts are still necessary for (1) a better understanding of key parameters of field efficacy in relation to the type of biocontrol agent and their modes of action and (2) implementing the most promising methods for efficacy improvement. Promising avenues of research are to be sought both in terms of exploiting the biological properties of the biocontrol agents and enhancing their effectiveness through formulation of the products. Results obtained on these topics should provide key information both for the design of optimised production and application strategies, but also for improving the screening process of future biocontrol agents as mentioned in the point above.

**Promote multidisciplinary approaches to integrate better biocontrol with IPM and other production issues.** Based on passed published experience, it is clear that levels of protection provided by a single biocontrol agent alone will seldom be sufficient, especially when faced with field conditions unfavourable to their effectiveness or with very high inoculum pressures of a pest or plant pathogen. More emphasis will need to be placed on the compatibility of biocontrol agents with the implementation of IPM, preferably in a systemic approach of integrated production. Among the many possible interactions to be considered, compatibility and combined use of biocontrol and plants genetically modified for improved resistance to pest or plant diseases should not be overlooked.

**Develop adapted delivery technologies.** Much progress has been made in packaging technology and delivery for macrobial biocontrol agents (e.g. beneficial arthropods). In contrast, treatments with microbial biocontrol agents (against pests or diseases) still rely on sprayers developed for the application of pesticides. Research is needed to provide growers with low pressure spraying equipment to preserve the viability of the microbials. Technological improvements are also needed for optimal coverage of the target plant surfaces to be protected by the biocontrol agents.

**Safeguard the durability of biocontrol.** Certain pests and pathogens are known for their capacity to develop resistance to chemical pesticides or to overcome varietal resistance. The durability of biological control has often been assumed to be higher than that of chemical control, but several examples of resistance of pests have already been reported. Much less is known about plant pathogens, probably in part because biological control against diseases is still very rare. Significant research efforts are needed to anticipate the potential hurdles in this domain and integrate durability concerns both in the screening of new biocontrol agents and in the careful management of their use once they become commercially available.

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<sup>\*</sup>Köhl, J., Postma, J., Nicot, P., Ruocco, M., Blum, B. 2011. Stepwise screening of microorganisms for commercial use in biological control of plant pathogenic fungi and bacteria. *Biological Control* 57, 1-12.

## Issues for development

Three key issues have been identified in terms of development. They are directly related to improving the efficacy of crop protection but also to acceptability of biocontrol by farmers.

**Training of advisers and farmers.** Compared to chemical control, the implementation of biological control presents an additional level of technical complexity when the "active substance" is a living organism or microorganism, whose liveliness and development on the target crop underpins the effectiveness of the protection. In many situations, achievement of successful biocontrol of pests has been linked to an active role of advisers in accompanying the farmers, at least during their initial phase of adoption and implementation. The success of large scale use of biological control in the future will require stepping up the technical training of farmers and of advisors. Such action will also positively influence the adoption issues mentioned below.

**Development and dissemination of Decision Support Systems (DSS).** Growers routinely make decisions that take into account multiple constraints (both technical and economic) of their activity. However, the complexity of biocontrol and its necessary integration in a systems approach of crop protection and crop production make DSS more and more indispensable, including in their function as easily consultable repositories of knowledge on available choices.

**Establishment of demonstration schemes and development of farmers' networks.** This action is needed to stimulate the dissemination of information to and among farmers, but also to facilitate exchange between the end users of biocontrol and the other actors of research, development and commercialization of the products. Breaking up regional and national barriers and including a European dimension to such networks is desirable for optimal efficacy of multisite experimental trials.

## Industrial issues

**Quality control.** Ongoing efforts by the manufacturers of biological control agents to guarantee the quality of their products need to be stepped up. The definition of tests and their routine implementation is crucial to ensure reliable effectiveness and maintain confidence of farmers for biocontrol. Whenever possible, such tests should include not only an evaluation of viability of the biocontrol agent but also an evaluation of physiological parameters related to its efficacy, based on knowledge of its modes of action.

**Improve distribution systems.** Distribution systems need to be improved to safeguard the quality of the products and provide technical advice for the users. In many cases, the distribution of biocontrol products is common with that of chemical pesticides. One possible avenue of progress would be to improve awareness on the specificities of handling biocontrol products, especially those containing living organisms or micro-organisms. Another would be the development of sizeable distributions networks focused on biocontrol, which could be brought together by groups of (currently often small) producers of biocontrol products.