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RESUMEN

Aunque el control biológico de fitopatógenos, como alternativa de control sostenible, ha despertado considerable entusiasmo en los últimos tiempos, la mayor parte de la investigación reportada hasta ahora, refleja más un interés académico que práctico desde el punto de vista de su aplicación. Es así como la mayoría de reportes hechos en la literatura científica están enfocados hacia la selección de cepas con potencial para el biocontrol y al estudio de sus mecanismos de acción. Sin embargo, temas prioritarios tales como la producción masiva, la formulación, la seguridad toxicológica y medioambiental, y la integración con otras formas de control, han presentado escaso desarrollo.

Development of Biocontrol Agents: Opportunities and Challenges for their Practical Application¹

ABSTRACT

The relevance of biocontrol agents in plant pathology is still limited in spite of the great enthusiasm generated by research on biopesticides. Most of scientific reports are focused on selection of strains and basic biochemical studies. Priority issues as mass production formulation of biocontrol agents, toxicological and environmental safety and integration into other control strategies are not completely developed.

INTRODUCTION

BIOPESTICIDES ARE generating a great enthusiasm as biotechnology in the agricultural sector in general, although the relevance of biocontrol agents (BCA's) in plant pathology today appears still limited. The real progress in the field of biological control is sometimes difficult to evaluate because of the overoptimistic published papers on the subject. Overemphasis of several partial results and exaggerated claims in the literature have overshadowed problems which must be identified and solved by the researchers if BCA's have to find their rightful place among the different strategies of plant disease control.

If we look at the research priorities as appearing through the bibliography collected in data bases, we may conclude that these priorities too often reflect more an academic care than a preoccupation on product development. A majority of papers concerns the screening tests, the methodology of evaluation for the biological activity, and the biochemical mechanisms of action. Before becoming an economically feasible alternative to chemical control, biopesticides must satisfy several requirements which must be considered as a whole:

- An effective microbial strain showing a reliable effectiveness must be selected.
- A technology providing high quality biomass and adequate formulation must be developed.
- A knowledge of the ecological requirements for survival, colonization and/or biological control activity is required.
- The toxicological confidence of the user's safety and the ecotoxicological safety must be controlled.

The technologies of mass production, the

formulation of biocontrol agents, and their integration into other control strategies are too often neglected. We must consider biological control not only as a scientific and academic subject of research but like another potential strategy which requires intergraded and multidisciplinary research oriented toward product development.

Selection of an effective biocontrol agent

A lot of biocontrol strains have been reported in the literature and it appears that the effectiveness of the potential BCA's is often high in controlled conditions (postharvest diseases) but consistency remains a problem in field conditions. This overshadowed point is a major bottle neck in the development of BCA's for use against aerial plant diseases.

Occasional difficulties in controlling diseases in field conditions were usually attributed to detrimental effect of environmental conditions (U.V. and low relative humidity are often reported as the responsible parameters) on the survival and/or the protective activity of BCA's on the target plant. Suggested solutions to this problem included: 1) a selection of BCA's that can resist in extreme environmental conditions, and 2) the formulations development that protect the BCA's from adverse conditions. In addition, appropriate formulations would also be expected to ensure a reasonably long shelf life for the commercialized BCA's, to enhance their efficiency, and to be compatible with common methods of application (sprayer). Such research is already under way in some laboratories but it is clear, however, that increased collaboration between plant

1. This summary updates the conclusions of a EC workshop held at Gembloux (Belgium) in 1993;

2. Visiting researchers at MIP Program of CORPOICA, A. A. 240142-Las Palmas, Santa Fe de Bogotá, Colombia; researchers at Unité de Phytopathologie, Faculté Universitaire des Sciences Agronomiques, 5030 Gembloux, Belgium.

pathologists and teams working on mass production and formulation of micro-organisms would greatly stimulate the crossing of BCA's from the laboratory to the practical application. Published data in this area remains sparse (perhaps because they may involve industrial secrets) in comparison with the considerable volume of literature describing selection procedure, mechanisms of action or genetics of BCA's. In this respect, useful insights could be expected from laboratories concerned with the development of BCA's against insect pests and weeds.

Knowledge of the mode of action

As we move towards the application of this technology, new research problems are emerging; among the mechanisms of action of these organisms were too often neglected and considered only as an academic concern. Tremendous efforts are being made to understand the modes of action of BCA's and their complex interactions with the host, the pathogen and the natural microflora. Such knowledge could be required in relation to some toxicological aspects of the BCA's registration but it constitutes also a pre-requisite for the development of rational formulation enhancing the efficacy of BCA's and for the development of the most appropriate methods and schedules of application of BCA's in the field. It may also provide the needed criteria for the development of quality control procedures for the industrial production of BCA's. Due to the complexity of this essential task, it is likely to remain a challenge and a research priority for many laboratories in the near future.

The ecophysiology of BCA's

In order to improve the reliability of the BCA's in field conditions, research efforts must be increasingly focused on the ecophysiology of BCA's, with the aim of developing predictive models of BCA's populations and their antagonistic activity on target plants, as affected by environmental parameters and natural microflora. A pre-requisite will be the development of the method for monitoring those populations and their antagonistic activity *in planta*. Molecular methods such as the use of antagonist-specific probes, "lux" gene markers, and DNA amplification technology will probably be of great assistance in the

near future and supplement already existing monitoring procedures.

Registration of BCA's and safety requirements

Issues associated with the environmental safety and the registration of BCA's is also perceived as another key step for the use of BCA's in agriculture. While the responsibility (and the associated costs) for registration usually falls upon the company developing a commercial product, many aspects related to this procedure must directly concern the scientists selecting BCA's, as criteria for the screening procedure. Among much debated questions were some concerning the possible problems encountered in the registration of BCA's which mode of action include antibiosis or that belong to groups of micro-organisms comprising some potential pathogenic species or strains.

It appears that the level of the requirements (and the associated costs) for the registration (toxicity and ecotoxicity) of plant protection can become so high that the development of products for the biological control of plant diseases could be discouraging for the industry considering the small potential market.

Biological agents used for the control of plant diseases are primarily living organisms. Their impact on the environment, and therefore, the safety requirements are likely to be somewhat different than those for chemical pesticides.

Conclusion

Research on biological control of plant diseases has resulted in the selection of large numbers of micro-organisms with high potential as biological control agents against plant diseases and it could lead to alternative strategy of plant disease control. Whether these research results can be transformed into economically viable tools for agriculture will now depend on the ability of researchers to attract the interest of industry.