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Abstract: The current socio-economic and political context is particularly favorable to the development of biocontrol products to control plant diseases. This review highlights the current status of microbiological control against plant disease in greenhouse crops and the future research needed to promote the use of biocontrol agents in practice.

According to Gwynn (2014), 44 microorganisms are commercially developed in the world against plant diseases of which 25 are fungi, yeasts or oomycetes, 14 are bacteria or actinomycetes and 5 are viruses. A recent review by van Lenteren et al. (2018) has identified 91 microbial biocontrol agents (49 fungi or yeast or oomycetes, 37 bacteria or actinomycetes and 5 viruses or phages) registered against plant pathogens in Australia, Brazil, Canada, the European Union, Japan, New-Zealand and the USA. This number of microbials is probably underestimated due to the lack of data in some countries, in particular in China and India, where the biocontrol industry is very dynamic. Despite an overall increasing number of marketed microbial-based products in the world, currently available products do not cover all plant diseases and it is therefore necessary to develop new ones. The development of a new biocontrol agent requires the screening of a large number of candidate strains on multiple criteria. A challenge for research will be to select more efficient microorganisms by taking better account of their ecological competence, the stability and the durability of their efficacy (Köhl et al., 2011; Nicot et al., 2011).

One of the main issues for the adoption of biocontrol against plant diseases by farmers is the reliability and stability of its efficacy in the greenhouse. The protective efficacy of biocontrol agents, and particularly microbial, is generally considered variable and inconsistent under cultural conditions (Nicot et al., 2011). Efficacy of biocontrol agents (especially that of microbes) is managed by complex factors linked to the changeable environmental conditions encountered in the field, to farming practices and to the biological properties of the biocontrol agent and of the target plant pathogen. It is therefore necessary to identify the perimeters of their efficacy and to ensure their integration into complex farming system in order to ensure optimal use of these products by farmers, for example by creating decision support tools.

Finally, knowledge concerning the possible erosion of efficacy of biocontrol agents is essential to ensure a durable efficacy of this control method on target plant pathogens. Although many plant pathogens are known for their capacity to develop resistance to classical control methods, only few studies have explored their ability to overcome the effect of biocontrol agents (Bardin et al., 2015). However, these studies highlight differences in the sensitivity of various isolates of plant pathogens to biocontrol agents or to compounds that are produced or synthesized, as the result of their interaction with the host-plant or with the plant pathogen. Moreover, the selection pressure exerted by an increase in the use of biocontrol agents may cause the emergence of new resistant phenotypes from these less sensitive isolates. Even if data are too sparse to conclude on the durability of biocontrol agents in practice, there is a necessity of proper management of these new products to avoid repeating

the mistakes made with the deployment of chemical pesticides and of certain biological agent against plant pests (Siegwart et al., 2015).

Key words: biocontrol, plant diseases, efficacy, durability, IPM

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