

Bioherbicide research at CENARGEN/EMBRAPA, Brazil

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The biological control of weeds programme developed at the National Research Centre of Genetic Resources and Biotechnology (CENARGEN, Brazil) is divided into three main research areas. The first is the collection, selection, characterization and conservation of micro-organisms with potential as biological control agents. Secondly, we survey, screen and conduct preliminary host-specificity tests of selected insect species that have potential as biological control agents of priority weeds. These two research thrusts are concentrated on a few important agricultural weeds, such as *Cyperus rotundus*, *Senna obtusifolia*, *Amaranthus* spp., and *Chenchrus echinatus*, and on water hyacinth (*Eichhornia crassipes*). The third area of research is the development of bioherbicides based on *Cercospora* sp. (tentatively identified as *C. caricis*) and *Alternaria cassiae* for the control of *C. rotundus* and *S. obtusifolia*, respectively. Studies on host-specificity, host/pathogen interactions (including physiological specialization of isolates) and methodologies of inoculum production are being conducted with these two fungi. An overview of these studies was presented.

Formulation and delivery of microbial herbicides

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The microbial herbicide products introduced to the market in the United States of America in the early 1980s worked reliably and effectively until they were withdrawn for economic reasons in the early 1990s. This record of reliability was the result of 'Collego' used in paddy rice or irrigated soybean, where moisture conditions for the fungus were appropriate, and 'Devine' being used as a soil inoculum which were thus buffered against moisture fluctuations. Subsequently, potential products have not been so fortunate and have been unreliable in the field, largely due to environmental constraints. Efforts to improve this situation have focused on formulation of the inocula, particularly to protect it from inadequate moisture levels. Formulations are often based on complex mixtures of adjuvants that were developed for application to target-leaves and the soil. These formulations were reviewed in the light of their efficacy and suitability for use in practical conditions in the available markets. Possible future directions in the development of formulations were discussed. Despite the growing recognition that formulations must play a critical role in the successful practical use of microbial herbicides, little or no attention has been paid to their successful delivery to the target. This is surprising considering the wealth of knowledge about the impact of spray-application parameters on chemical herbicide efficacy. There is no reason to suppose that these parameters are any less critical in the delivery of biological agents. It is obvious that reducing the application volume from the high levels used when experiments are sprayed to run-off, to practical levels of less than 200 l ha⁻¹, or preferably less than 20 l ha⁻¹, will have significant impact on the spore-dose that can be delivered, the way the spores are distributed on the target and, hence, on their ultimate success in establishing infection and disease. Much needs to be done in this area; for example, what is the best spray droplet size for carrying the appropriate number of spores to produce infection? Such questions need answering for different fungal pathogens and for different formulations of them. Some recent research in this area and its implications for microbial herbicide development and formulations were discussed.