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Benefits and constraints of using bioherbicide in weed management

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Plant pathogens hold enormous potential as bioherbicide. In addition to the use of plant pathogens as bioherbicide, it is likely that pathogen derived genes, gene products, and genetic mechanisms will be exploited in the near future to provide novel weed-management systems. On the other hand, the present over-reliance on chemical herbicides is purely on economic considerations, at the exclusion of ecological and social benefits. Thus the serious limitation of environment could site use of bioherbicide.

Benefits in using bioherbicide : A number of benefits are there which proves the necessity for the development of bioherbicides. No chemical residue buildup or pollution to the environment. It is more of an ecological and eco-friendly approach. Herbicide resistance can also be seen as a driver for research into bioherbicide development. The research of Ash, Cother and colleagues (Cother, 1999) was supported in part due to the emergence of resistance in the target weed to synthetic pesticides. They demonstrated that the fungus *Plectosporium alismatis* could be used to manage weeds in the rice fields in Australia. Jahromi *et al.* (2006) suggested that synergy between *P. alsimatis* and selected herbicides could lead to reduced herbicide application rates. Synergy with synthetic herbicides has been seen as a mechanism to overcome resistance in the host and therefore reduce the application rate of both the herbicide and the biological control agent in a number of systems. Due to the enormous costs involved in the production of synthetic pesticides, global companies have tended to focus on the registration of pesticides in the major crop/cropping systems. This has led to a number of attempts to develop bioherbicides in these non-cores or niche markets. These markets could be of considerable size and include those which have been created by synthetic herbicide withdrawal and the organic food movement. The use of mycoherbicides is compatible with the philosophy of organic food production, provided the agent had not been genetically modified, the carriers and adjuvants are natural products and the host range is not considered to be too wide. This market for bioherbicides might be larger than first predicted due to the localization and even globalization of organic food.

Hallett (2005) suggested that parasitic weeds could offer a niche system for the implementation of bioherbicides as parasitic weeds are not adequately controlled through the use of herbicides or traditional weed management strategies. As an example of this approach, dodder species (*Cuscuta* spp.) have been targeted using the fungal pathogen *Alternaria destruens*. Additionally, Lubao II, a formulation of *Colletotrichum gloeosporides* f.sp. *cuscutae* has been used in China for dodder control. Considerable research has also been undertaken on the biological control of striga (*Striga* spp.) and broomrapes (*Orobanche* spp.). In addition to these biological/social drivers for the production and adoption of bioherbicides, there are changing economic drivers. The increase in the cost of farm inputs and the price for farm products in recent years will also have an impact on bioherbicide research. It may be expected that farmers will be prepared to pay a premium for inputs such as bioherbicides and this is likely to affect the types of approaches used to produce new bioherbicide products in some markets.

Constraints in using bioherbicide : The constraints affecting the implementation of bioherbicide are described below :

Constraints of statutory and regulatory requirements: Legislation is an opportunity to ensure the safe use of bioherbicides. Failure to obtain approvals for importation and testing from specialized organizations might endanger any intensive bioherbicide research project. Such laws and rigorous risk assessment of new formulations can cause delays in releasing, increased costs and decreased benefits. Most countries require bioherbicide registration in accordance with pesticide laws prior to initial use. This can be a limitation to development as bioherbicide markets are not large enough to restore registration costs in a reasonable period of time.

Constraints of funding and conflicts of interest : Although many long-term research projects are initiated around the world but uncertainty continues. The fact that bioherbicides have slow action on weeds generates a primary problem, especially when the control strategy is to quickly reduce a weed population below an economic threshold. Long-term funding by donors, particularly in developing countries, is scarce. The presence of many effective, selective, economical and relatively safe chemical herbicides is a strong disincentive to the pesticide industry for developing bioherbicides.

Technological constraints in developing bioherbicides: Several technological constraints have been identified that could prevent the widespread use of bioherbicides. Pathogenical strains, formulation method and the interaction of these two parameters significantly affect the shelf-life of the formulations at room temperature. The ability to produce fungal biomass in large-scale fermentation and to formulate it into readily useable material is very essential. High concentrations and the alteration of formulations are needed to increase bioherbicide activity. Compatibility testing of formulation components that range from registered agricultural products to novel substances, such as sunscreens, humectants and starches, can consume a great deal of time and resources (Bayer *et al*., 1999).

Environmental constraints : Environmental factors are also among the primary factors that influence formulation performance of bioherbicides as inoculum production is dependent on sporelation of the formulation. This process, although rapid, might continue over several weeks subsequent to applications and might encounter variable environmental conditions. In the application of bioherbicides, environmental conditions prevailing in the phyllosphere of plants are frequently hostile for biological control agents. Soil environment, moisture and the nutrient status of the soil can influence the physiology of target plants and, therefore, their interaction with aerial applied bioherbicides. Climate change, including global warming and increased climatic variability, is likely to affect weed management, including biological control. The impact that these changes might have on the efficacy of options available to manage weeds will need to be assessed.

Host specificity and ecologic constraints : One of the most important host specificity constraints is that bioherbicides have a very narrow herbicidal spectrum. This is a major reason for the unsuccessful introduction of bioherbicides onto the market. Amsellem *et al*. (1999) have emphasized that, prior to developing a specific bioherbicide for any weed, we must first characterize the genetic diversity of the plant in every area into which it has been introduced and compare this with its diversity in its native range.

Human-related constraints : Procedural errors (the human factor) are frequently the sources of failures in bioherbicide. As the number of personnel lacking experience and expertise in bioherbicide has grown, local failures have increased. Lacking of adequate training and provision of information to secondary users are also play a significant human related constraint in using bioherbicide in weed management.

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