Agrotec (2012) 2: 78-81

Biological degradation of pesticides: a solution to the problem of environmental contamination

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Keywords: Biological degradation, pesticides, environment, crop protection

Abstract

The constant and exponential growth of world population has been leading to an increasing demand on food and fiber. As arable land is limited, yields must continuously improve. Pesticides constitute one important group of crop protection products that contribute to increase agricultural production yields. Nevertheless, the intensive production and use of these chemicals is controversial due to the potential environmental contamination, bio-toxicity and human health hazards. In order to protect the quality of natural resources and prevent risks to human health, countries around the world created organizations that evaluate and regulate the use of pesticides and other potentially toxic compounds. Despite all these directives, numerous studies have reported the presence of xenobiotics in the environment, sometimes above the legally recommended values, raising major health problems. Therefore, the development of treatment strategies, able to contribute for the decontamination of polluted sites and prevention of future contaminations, is essential to assure sustainable agricultural practices.

The multitude of technological solutions available to treat xenobiotic contaminated sites can be divided into physical-chemical and biological remediation processes. Bioremediation methods are potentially more efficient, economically advantageous and environmentally safe as the complete breakdown of contaminants may be achieved. Therefore, bioremediation is increasingly preferred over more traditional processes, such as incineration, to decontaminate waters and soils.

Several bioremediation strategies, *in situ* and *ex situ*, have been developed to treat contaminated wastes and sites polluted with pesticides. *In situ* strategies include natural attenuation, also known as intrinsic bioremediation, biostimulation and bioaugmentation. Natural attenuation consists on the degradation of toxic compounds by indigenous microorganisms, without any addition, modification or interference. Biostimulation is a type of natural remediation in which the degradation capabilities of the indigenous organisms are improved due to the introduction of bio-activity promotors. Bioaugmentation consists on the addition of exogenous microorganisms able to biodegrade the target contaminant. The unpredictability of *in situ* methods and the possible limitation by the heterogeneity of the polluted site can seriously hamper the effectiveness of this type of processes. Alternatively, *ex situ* bioremediation strategies such as land farming, composting, biopiles (hybrid of land farming and composting) and bioreactors can be adopted as treatment solutions.

The success of bioremediation methods is mainly based on the efficiency of microorganisms and on the stability of the xenobiotic in the polluted site. Thus, prior to implement a remediation process it is essential to characterize the contaminated site and to assess the conditions influencing biodegradation in order to assure the efficient growth and activity of the degrader organisms and hence an efficient decontamination.