Chapter 3
Bioremediation of Pesticides under the Influence of Bacteria and Fungi

Mamta
Jiwaji University, India

Rayavarapu Jaganadha Rao
Jiwaji University, India

Khursheed Ahmad Wani
ITM University Gwalior, India

ABSTRACT

The demand and development of chemicals, pesticides, fertilizers, and pharmaceuticals is increasing constantly posing a potential threat to the environment. The presence of pesticides and their impact makes their removal and detoxification a more urgent need. Bioremediation technologies have been successfully used and are gaining more and more importance with increased acceptance of eco-friendly remediation solutions among the scientific community. Bioremediation by fungi and bacteria is considered a better option for making environment free from pesticides, as chemical and physical methods are not only costly but also not very effective. However, the complex nature of pesticides is an obstacle to degrade the pesticides, so more versatile and robust microorganisms need to be identified which can produce the desired result in a very cost-effective manner. This study examines the role played by fungi and bacteria in degradation of the pesticides in environment and also identify the future research problems in this regard that need to be experimented.

INTRODUCTION

Rapid industrialization, urbanization and population growth has deteriorated the environment condition and is considered a threat for different kinds of ecosystems in many ways. Currently, land, water, air resources have become contaminated due to various toxic organo pollutants, viz., herbicides, insecticides,

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pesticides, plasticizers, coloring dyes, agrochemicals, solvents, pharmaceuticals, hydraulics, heavy metals, fire extinguishers, halogenated compounds, hazardous metal ions, etc. Human health and agricultural sustainability is seriously affected by the synthetic pesticides produced during the last 10 decades. The process of solidification and evaporation has exposed the environmental ecosystems to different types of pesticides and most of the pesticides are present in concentrations that are toxic to not only humans but to soil, water, marine and estuarine ecology. Pesticides traces have been found even in the samples of rain, fog and bark of trees as well.

Among the most persistent and globally distributed organic pollutants are hexachlorocyclohexane (HCH) and dichlorodiphenyltrichloroethane (DDT), hexachlorobenzene (HCB), heptachlor, aldrin, chlordane, dieldrin, endrin and mirex. Most of the organic compounds are synthetic and recalcitrant to photolytic, chemical, and biological degradation and due to their volatile nature these pesticides move long distances that results their distribution across the earth, including remote and isolated areas such as the Polar Regions (Allen-Gil et al., 1997). The pesticides can be transported in the vapour phase, surface runoff and leaching. The process of evaporation takes place due to tropical warm temperature and hence it is argued that trace of pesticides may be found in the atmosphere in areas where the temperature is high as compared to colder places. The concentration of pesticides will be highest near the point of release and decline with distance. However, mobile organo chlorine compounds that have their tendency to partition for easy movement are the exceptions (James, 2000). HCH isomers, DDT and its metabolites that are persistent organic compounds are the predominant chemical contaminants found along the Indian coast and were reported in major rivers (Rajendran & Subramanian, 1997; Zhou, Zhu, Yang, & Chen, 2006; Leong, Tan, & Mustafa, 2007; Imo, Sheikh, Hirosawa, Oomori, & Tamaki, 2007; Ma, Ran, Gong, & Zou, 2007; Ize-Iyamu, Asia, & Egwakhide, 2007; Kannel, Lee, Kanel, Khan, & Lee, 2007; Poolpak, Pokethitiyook, Kruatrachue, Arjarasirikoon, & Thanwaniwat, 2008; Doong, Lee, Lee, Sun, & Wu, 2008; Kaushik, Sharma, Jain, Dawra, & Kaushik, 2008). Organochlorine pesticide (OCPs) residues are important potential component of chemical pollutants used extensively for agriculture and sanitation purposes in India. These Pesticides enter the soil and ground water by direct treatment or being washed off from plant surfaces during rainfall. Depending on the phenotype and density of the plant type, it is estimated that an average of 35-50% of the plant protection material is deposited on soil immediately after spraying. The behavior of pesticides in soil and ground water involves persistence, movement and metabolism. The water solubility and binding capacity of organic and in organic constituents is an important factor for function of residues.

Due to the adverse effects of pesticides, especially DDT and HCH there use in agriculture has been banned in most countries. However it has not completely eliminated the residues of these compounds and their metabolites from the environment (Bhatnagar et al., 1992; Bhattacharaya, Sarkar, & Mukherjee, 2003). On the other hand India is still one of the major producer and consumer of organochlorine pesticides, particularly dichlorodiphenyltrichloroethane (DDT) and hexachlorocyclohexanes (HCHs) for agriculture and public health programs although it is banned. The consumption of insecticide in agriculture has been increased more than 100% from 1971 to 1994-95. For instance, insecticide consumption in India, which was to the tune of 22013 tons, has increased to 51755 tons by 1994-95 (www.indiastat.com). The Indian pesticide industry with 82,000 MT productions for 2005-06 is ranked second in Asia (behind China) and twelfth on global market. According to Green Peace report, India is producing 90,000 metric tons of pesticides as the largest industry in the whole of Asia. India as most of the rivers pass through agricultural fields, they are subjected to contamination with different pesticides used for crop protection (http://www.greenpeaceindia.org/nopesti.htm). It is estimated that about 25 tons of
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