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Bioremediation of Mixed Pesticide-Contaminated Agricultural Soil Using Biosurfactant-Producing Bacterial Consortium

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Background/Objectives. Endosulfan, Chlorpyrifos and Cypermethrin are the most commonly applied pesticide on crops either singly or in mixed form. Among these, endosulfan is one of the most persistent organochlorine pesticides, having a half-life of degradation of 60 to 800 days in soil with a water solubility of 0.33 mg/L at 25°C and a soil adsorption coefficient of 3.5. The other two pesticides, chlorpyrifos and cypermethrin, belong to the class of organophosphate and pyrethroids, respectively, and are also less soluble (1.39 and 0.004 mg/L) with a soil half-life of degradation of 70 to 160 and 60 to 800 days, respectively. The less water solubility of these pesticides makes them less bioavailable and persistent in the environment. Hence, a method for enhancing the bioavailability of pesticides like endosulfan, chlorpyrifos and cypermethrin in surface and subsurface soil by bioaugumenting a biosurfactant producing bacterial consortium in soil is studied.

Approach/Activities. Pesticide-spiked agricultural soil was enriched with a biosurfactant producing bacterial consortium and their capability in enhancing the bioavailability of pesticide is evaluated in a soil reactor.A glass reactor of volume 4500 cm3 with height 40 cm, length 15 cm and width 10 cm was used as the experimental setup. The study was carried out for duration of 30 days at a pH of 7.0±2 (original soil pH) and moisture content of 20%. Survival of the introduced bacteria and other native bacteria assisting the bioremediation is confirmed using molecular techniques like DGGE and specific primer based studies.

Results/Lessons Learned. Among the three pesticides, degradation of chlorpyrifos was faster and it was completely degraded at the end of 20th day in all the layers of soil. A complete removal of α endosulfan was observed on 30th day in all the layers of soil. The percent degradation of cypermethrin was very less, 35% and 60 % in surface and subsurface soil (15-30 cm). In the subsurface soil (30-40 cm) 95% of cypermethrin was utilized by the consortium. The major metabolites of endosulfan detected were endosulfate and endosulfandiol. In the case of chlorpyrifos, metabolite formed in surface soil was Phosphoric acid tris (2-chloro-1-methylethyl) ester whereas in the subsurface soil it was not detected. Major metabolites of cypermethrin detected in surface soil were 2-Propenoic acid, 2-cyano-3,3-diphenyl-, ethyl ester and cis-11-Eicosenamide whereas in the subsurface soil and bottom soil only cis-11-Eicosenamide was detected.DGGE analysis and specific primer based study confirmed the survival of bacterial strains in the soil. The study revealed that the consortium can survive in a mixed pesticide contaminated soil and was able to enhance the degradation of all the three pesticides in surface and subsurface soil. The study also revealed that bioaugumentation of biosurfactant producing bacterial consortium enhances the bioavailability of endosulfan, chlorpyrifos and cypermethrin in the soil and thereby the bioremediation process. From the study it can be concluded that bioaugumentation of contaminated soil with biosurfactant producing bacterial strains capable of surviving in subsurface soil environment can enhance the bioremediation process.