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Microbial Remediation of Soil Contaminated with Pesticides and other Hazardous Chemicals-Present and Future

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For the last several decades our environment has been continuously exposed to toxic petrochemicals, synthetic pesticides, heavy metals, solvents, radionuclides and many other organic and inorganic pollutants. The persistence of several anthropogenic chemicals, their biomagnification in the food chain and eventual entry in to human body have been a matter of grave concern. In recent years attempts are being made world over to clean up the contaminated ecosystems. Among the few options available for this purpose microbial bioremediation is the most promising one. As microbes can utilize organic chemicals as carbon and energy sources the pollutant chemicals are completely mineralized and hence is the preferred method. Microbes are also endowed with the ability to adapt themselves and proliferate even in inhospitable environments. Microbial remediation is safer, effective and less expensive.

Organochlorine pesticides such as BHC, DDT, heptachlor, aldrin and a dialdrin etc. are major contaminants in food, and hence, are found in high concentrations in human adipose tissue. Elimination of these toxic chemicals from the environment is the only option available for obtaining safer food. There are several reports of bioremediation of soils contaminated with some of these pesticides residues. Aerobic degradation of α-HCH in heavily contaminated soil slurry by native microorganisms has been reported (2). Wade et. al. (14) have reported rapid degradation of γ-HCH in upland soil after multiple applications of the compound. Accelerated degradation of γ-HCH in flooded and upland soils after pretreatment of the soils with HCH was observed (4). Sahu *et. al.* (13) have shown the degradation of soil applied and α-andγ-isomers of HCH on inoculation with a *Pseudomonas* sp. A microbial consortium that can degrade and α-,β-,γ-and -isomers of HCH has been developed in our laboratory which has indicated its ability to degrade soil-bound HCH isomers too. We also have shown that *Pseudomonas aeruginosa* strain DT-Ct-2 isolated from soil effectively bioremediated DDT-contaminated soil. Complete mineralization of 15 μg DDT g^{-1} soil occurred within 96 h. The organism was effective even in native soil containing organic matter.

A number of herbicides and their catabolities have been shown to deleteriously affect the germination of seeds as well as young seedings of certain crop plants. Seedings of peas and soybean are highly susceptible to even low concentrations of dicamba (3, 6-dichloro-2-methoxybenzoic acid) and inoculation of soil with dicamba-degrading bacteria protects the seedlings from the deleterious effects. Similarly 3-chloro- and 4-chlorobenzoates (3-CBA and 4-CBA) and 2,4,5-trichlorophenoxyacetic acid (2, 4, 5-T) inhibit germinations of seeds of tomato, tobacco, egg plant (brinjal) and other *Solanacenae* members. Treatment of soil be chlorobenzoate degrading *Pseudomonas aeruginosa* 3mT and 2, 4, 5-T-degrading *Burkholderia cepacia* AC 1100 eliminated the toxic effects of chlorobenzoates and 2, 4, 5-T, respectively. Bioremediation of 3-CBA-contaminated soil by inoculating with *Pseudomonas alcaligenes* C-O has been reported has also been shown (6). Degradation of chlorobenzoates in soil slurry. Soil degradation of 2, 4-dichlorophenoxy-acetic acid (24-D) was demonstrated[9]. Rapid mineralization of atrazine in soil slurry and moist soil be a *pseudomonas* sp. and the dependence on inoculum density and soil moisture have been reported (5). Bioremediation of pentachlorophenol-contaminated soils by straw compost and bioremediated soil inocula (11), by bioaugmentation using activated soil (3) and by solid substrate cultures of the "shiitake" mushroom, *Lentinula edodes* LE2 (12) have been shown. Efficient biodegradation of chloroanilines and chlorobenzens in soil slurries by specialized organisms has been demonstrated (5).

Bioremediation technologies are gaining popularity and are here to stay. However, there is a need to isolate more and potent microbes and develop them to be able to withstand, thrive and remediate specific contaminated sites. Mixed cultures have been proved to be more efficient in bioremediation processes. But the success will lie on the judicious selection and formulation of microbial consortia to suit the given situation. Caution however, has to be taken to evaluate the impact of the inoculated organisms on the ecosytem.

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Effect of Different Sources of Organic Nitrogen with and without Inorganic Fertilizer on Growth and Yield of Rice

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The present investigation was carried out to assess the effect of different sources of organic nitrogen with and without inorganic nitrogenous fertilizer on the yield of rice.

The field experiment was conducted during *'Kharif'* season of 1995 and 1996 at the experimental field of college of Agriculture, CAU, Imphal. The experimental soil had the following characteristics : texture clay, pH 5.5, high in organic carbon, available P and K and medium in available N. The organic manure @ 10 tonnes/ha was incorporated into the soil two weeks before transplanting rice and allowed to decompose under submerged condition, expect FYM (decomposed) applied 2 days before transplanting and *Azotobacter* @ 1 kg/ha inoculated on the seedings just before transplanting. Inorganic N was applied as basal dressing.

Application of organic manures had significant effect on grain yield of rice as compared with control (Table 1).

Yield attributes viz. plant height, effective tillers, no of panicles/m^2, panicle length, no of filled grains/panicle, 1000 grain weight, grain yield and straw yield increased due to the application of organic manures in conjunction with inorganic N fertilizer than applying either inorganic or organic N sources alone. Pham[2] also reported similar observation. A basal application of FYM or straw or Ipomea or Azolla @ 10 t/ha in conjunction with 30 kg N/ha is equivalent of the yield obtained from N_{30}+30 (5.44 t/ha). Among the twelve treatment, Azolla+N_{30} gave maximum plant height (85.80 cm.), straw yield (4.68 t/ha), and second highest in grain yield (5.49 t/ha). Azolla increased plant height, effective tillers, test weight, filled grains and straw yield and supported. The treatment, Ipomea + N_{30} gave the maximum grain/panicle (108.95 no) and grain yield (5.57 t/ha). Green manuring of Ipomea increased plant height number of effective tillers/m^2, test weight number of filled grains/panicle and straw yield such effected wan also observed reaction (3)