A Novel Technology of Solarization and Phytoremediation enhanced with Biosurfactant for Sustainable Treatment of PAH-Contaminated Soil

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Abstract-The Niger Delta, Nigeria, is one of the world's largest delta and wetland. It is considered one of the ten most important wetlands and marine ecosystems in the world. However, since the advent of oil discovery in 1956, land contamination caused by hydrocarbons has been a serious problem throughout the Niger Delta region. Globally, remediation of contaminated land presents enormous challenges made more demanding by the current need for sustainable approach solutions. Conventional remediation techniques applied to clean up contaminated land are found to consume energy and water, generate wastes, pollute the atmosphere and produce greenhouse gases that contribute to climate change. The aim of this study was to evaluate the potential application of soil solarization amended with biosurfactant in conjunction with phytoremediation. The effects of this technology on microorganisms in the rhizosphere and their enzymatic activities in aged 240 mg/kg polycyclic aromatic hydrocarbon (PAH) contaminated soil were also examined. A 4 x 4 cells microcosm was constructed in laboratory to simulate the subtropical conditions in the Niger Delta. Solarization was carried out for 28 days before introducing seedlings of *Chromolaena odorata*-a common native plant found in Nigeria, for a 84 day phytoremediation period. At 1 cm depth, the mean temperature for solarized soil were 49.8 and 51.0^{o}C for biosurfactant amended and unamended treatments respectively; whereas the mean temperature for non-solarized soils were 43.9 and 44.3^{o}C for biosurfactant amended and unamended treatments respectively. The result showed that soil solarization has significant effects (p<0.05) on the height of the vegetated treatments with mean height of 55.00±4.08 and 52.50±2.89 over non-solarized with mean height of 45.75±4.35 and 43.75±2.99 cm for biosurfactant amended and unamended treatments respectively; and total % PAH removal with 96.25 and 95.73 over non-solarized with 81.75 and 78.29 for biosurfactant amended and unamended treatments respectively. There was also a statistically significant difference (p<0.05) in PAH removal between vegetated treatments and their unvegetated counterparts. The presence of plant significantly enhances the microbial population in the rhizosphere with a highest mean count of 185, 100 and 97 x 10^5 cfu/g dry soil for bacterial, actinomycetes and fungi respectively. There was a significant increase in rhizosphere enzymatic activities of urease in post-solarized treatments (p<0.05) and of dehydrogenase and urease in all vegetated treatment (p<0.05) compared to their non-solarized and unvegetated counterparts suggesting an overall indication of the activity of various microbial communities, including bacteria, actinomycetes, and fungi which have been implicated in PAHs degradation in soil. The study showed that solarization and phytoremediation using native plants is sustainable, environmentally friendly and cost effective thus opens up new possibilities for sustainable approach to remediate contaminated land.

Key words: Solarization, Phytoremediation, Niger Delta, Contaminated soil, Biosurfactant, Polycyclic aromatic hydrocarbons (PAHs).