THE USE OF COMPOSTED POULTRY LITTER AS A CO-SUBSTRATE TO STIMULATE THE BIODEGRADATION OF 2,4-DINITROTOLUENE IN FIRING RANGE SOILS

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Abstract: 2, 4-Dinitrotoluene (2, 4-DNT) is a single-based propellant, that is frequently used in military training exercises throughout the United States. 2, 4-DNT and its transformation products have the potential to cause ecological and health hazards due to their toxicity and mutagenicity. In situ bioremediation may be a cost effective means for the remediation of contaminated soils on firing ranges, specifically at firing points. The topical addition of organic waste products such as composted poultry litter to contaminated sites could be used to stimulate the biodegradation of propellants like 2, 4-DNT, via the addition of co-substrates, nutrients and microbes. In this study, we investigated whether the addition of organic and inorganic amendments could stimulate the indigenous microbial biodegradation of this propellant in contaminated firing range soils at Camp Edwards Military Range in Massachusetts (MMR). Microcosms containing 100 g of MMR soil were amended with 10 mg/kg of 2, 4-DNT, organic or inorganic fertilizer at 5% (w/w) and water to a moisture content of approximately 15 % (w/w). The organic fertilizer was a composted poultry litter (CPL) containing 27.6 % organic carbon and 3:2:3.3 N:P:K, and the inorganic fertilizer was a commercial fertilizer (inorganic amendment) containing 13:13:13 N:P:K. All treatments were replicated three times with sacrificial time points at days 0, 14, 28, 36, 60 and 70. Treatments were as follows: unamended-MMR soil only; MMR soil + CPL; and MMR soil + inorganic amendment. Microcosms were incubated in the dark at 25°C and 70 % relative humidity. 2, 4-DNT degradation rates were significantly slower in the unamended soil (half-life = 12.4 d) compared to the inorganic or CPL amended soils (half-lives = 8-9 d). After 70 days of incubation, the amount of 2, 4-DNT degraded was significantly different for all treatments with the highest amount occurring in the CPL amended soils (73 %) and 57.8 % and 48 % degraded in the inorganic and unamended treatments, respectively. The microbial biomass, measured as the total cellular fatty acid, increased from day 0 to day 70 in all samples, but was highest in the soils amended with the CPL. The relative amount of microbial biomass detected by PLFA analysis, correlated with the biodegradation of 2, 4-DNT. The results showed that the unamended soil alone contained microorganisms capable of degrading 2, 4-DNT, but the addition of the organic amendment had a significant positive effect on the rate and extent of biodegradation of 2, 4-DNT in MMR soil.

Keywords: In situ bioremediation, 2, 4-Dinitrotoluene, biodegradation