Biodegradation of insensitive munition formulations IMX101 and IMX104 in surface soils

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Abstract

The biodegradation potential of insensitive munition melt cast formulations IMX101 and IMX104 was investigated in two unamended training range soils under aerobic and anaerobic growth conditions. Changes in community profiles in soil microcosms were monitored via high-throughput 16S rRNA sequencing over the course of the experiments to infer key microbial phylotypes that may be linked to IMX degradation. Complete anaerobic biotransformation occurred for IMX101 and IMX104 constituents 2,4-dinitroanisole (DNAN) and 3-nitro-1,2,4-triazol-5-one during the 30-day incubation period with Camp Shelby (CS) soil. By comparison, soil from Umatilla chemical depot demonstrated incomplete DNAN degradation with reduced transformation rates for both IMX101 and IMX104. Aerobic soil microcosms for both soils demonstrated reduced transformation rates compared to anaerobic degradation for all IMX constituents with DNAN the most susceptible to biotransformation by CS soil. Overall, IMX constituents hexahydro-1,3,5-trinitro-1,3,5-triazine and 1-nitroguanidine did not undergo significant transformation. In CS soil, organisms that have been associated with explosives degradation, namely members of the Burkholderiaceae, Bacillaceae, and Paenibacillaceae phylotypes increased significantly in anaerobic treatments whereas Sphingomonadaceae increased significantly in aerobic treatments. Collectively, these data may be used to populate fate and transport models to provide more accurate estimates for assessing environmental costs associated with release of IMX101 and IMX104.

KEYWORDS: Biodegradation; IMX101; IMX104; Insensitive munitions

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