Limited recovery of soil microbial activity after transient exposure to gasoline vapors

During gasoline spills complex mixtures of toxic volatile organic compounds (VOCs) are released to terrestrial environments. Gasoline VOCs exert baseline toxicity (narcosis) and may thus broadly affect soil biota. We assessed the functional resilience (i.e. resistance and recovery of microbial functions) in soil microbial communities transiently exposed to gasoline vapors by passive dosing via headspace for 40 days followed by a recovery phase of 84 days. Chemical exposure was characterized with GC-MS, whereas microbial activity was monitored as soil respiration (CO2 release) and soil bacterial growth ([3H]leucine incorporation). Microbial activity was strongly stimulated and inhibited at low and high exposure levels, respectively. Microbial growth efficiency decreased with increasing exposure, but rebounded during the recovery phase for low-dose treatments. Although benzene, toluene, ethylbenzene and xylene (BTEX) concentrations decreased by 83-97% during the recovery phase, microbial activity in high-dose treatments did not recover and numbers of viable bacteria were 3-4 orders of magnitude lower than in control soil. Re-inoculation with active soil microorganisms failed to restore microbial activity indicating residual soil toxicity, which could not be attributed to BTEX, but rather to mixture toxicity of more persistent gasoline constituents or degradation products. Our results indicate a limited potential for functional recovery of soil microbial communities after transient exposure to high, but environmentally relevant, levels of gasoline VOCs which therefore may compromise ecosystem services provided by microorganisms even after extensive soil VOC dissipation.
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