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Remediation of chlorpyrifos contaminated soil using biochar

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Abstract

Biochar is a natural material produced through the pyrolysis of agricultural waste under oxygen-limited conditions. The method creates a sponge-like structure that can adsorb various substances, making it a promising material for remediating pesticides, particularly the widely used insecticide chlorpyrifos. This experiment aimed to evaluate the effectiveness of biochar in remediating chlorpyrifos contamination in both soil leachate and surface runoff. The first experiment was conducted to investigate the potential of biochar in reducing chlorpyrifos contamination in the leachate on a lab scale. The experiment was a completely randomised design (CRD) with 3 replications and 4 treatments. Three different rates of biochar (0.1 %, 1.0 %, and 3.0 % w/w) were evaluated compared with the control treatment (without biochar). The soil contaminated with chlorpyrifos (700 mg/kg) was placed in glass columns (5 cm wide and 15 cm height), water was poured on top, and the liquid that leached out was collected for chlorpyrifos testing (using QuEChERS extraction with a gas chromatograph-mass spectrometer) after 1, 2, and 3 weeks. The second experiment was conducted to investigate the potential of biochar in reducing chlorpyrifos contamination in surface runoff under field conditions. The experimental design was a randomised complete block design (RCBD) with 3 replications and 4 treatments as follows: (1) control treatment (soil without biochar and chlorpyrifos application), (2) 3.0%-biochar application, (3) chlorpyrifos-contaminated soil (700 mg/kg), and (4) application of 3.0%-biochar to chlorpyrifos-contaminated soil. Water was applied to the field experiment by sprinkling until runoff appeared. The runoff in each treatment was collected for chlorpyrifos analysis at 0, 1, and 2 weeks after contamination. The results demonstrated the significant efficacy indicated the application of biochar as a soil amendment was particularly effective in reducing chlorpyrifos contamination in both laboratory and field trials. In the laboratory trial, applying biochar to soil at a rate of 0.1–3.0 % significantly lowered the chlorpyrifos levels in the leachate water that drains through the soil by about 40–93 % compared to the control. Furthermore, the field trial revealed an 80 % reduction in chlorpyrifos contamination in surface runoff was observed when biochar was applied to the soil at a rate of 3.0 % (w/w).

Keywords: Biochar, leached, pesticide, run off