

Assessing the potential for manganese accumulation in rice crops through indoor accumulation experiments

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The growth of the leisure sports industry has led to increased demand for large-scale resort facilities, such as golf courses. However, constructing such facilities using excavated rubble foundations for filling can have detrimental effects on nearby agricultural and livestock operations due to the potential release of heavy metals into the environment. In the study area of Hoeryong-ri, Ilgwang-myeon, Busan, where a golf course was recently constructed, contaminated surface water was observed, with red sediment originating from an outlet of the golf course. The use of contaminated surface water for rice cultivation in the research area prompted this study to investigate the potential effects of manganese (Mn) contamination on agriculture by conducting Mn accumulation experiments in rice crops and analysis of Mn concentration of surface water. Mn analysis through surface water sampling at 20 m intervals was conducted in March, May, July, and September. The accumulation experiment was carried out under controlled conditions of 23°C, 80% humidity, and a 16-hour photoperiod for a period of 5 days. Rice crops were cultivated in 300 mL of artificially contaminated solution with different initial concentrations (1, 5, 10 mg/L), and the Mn concentration in the solution was measured at 24-hour intervals. The result of the heavy metal analysis of surface water showed that Mn concentrations decreased from upstream (mean: 5,181 µg/L) to downstream (mean: 357 µg/L), and the maximum Mn concentration (6,757 µg/L) exceeded the maximum contaminant level (MCL: 50 µg/L, the US EPA). For the accumulation experiment, Mn concentrations in the solution decreased over time. After 5 days of Mn accumulation, the Mn removal efficiencies exceeded 88% for different initial Mn concentrations. The Mn accumulation in the roots did not significantly change with different initial concentrations while Mn was readily transported in the shoot. The results of this study suggested the possibility of manganese accumulation in nearby rice crops in the study area, emphasizing the need for effective management of environmental pollution resulting from golf course operations in the future.