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Effect of Biochar Amendment on Bioavailability and the Uptake of Cd by Crops in a Contaminated Paddy

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The objective of this field study was to investigate the biochar (BC) amendment techniques on the soil Cd available and Cd uptake by wheat (Triticum aestivum L.) and rice (Oryza sativa L.) in a contaminated paddy. BC was applied as a basal soil amendment before rice transplantation in 2009 at rates of 0, 10, 20, 40 t ha-1. The yield of rice and wheat, CaCl2 extracted Cd in soil, and Cd concentration in grain were monitored from 2009 to 2011. Results show that there were no significant effects of BC on grain yields of wheat and rice. Soil physicochemical properties and the distribution of Cd in plant tissues were found to be changed with different seasons. In rice season, soil pH were significantly increased by 0.15 - 0.33 units in 2009 and 0.24 - 0.38 units in 2010, and CaCl2 extracted Cd in soil decreased by 32.0 - 52.5 % in 2009 and 5.5 - 43.4 % in 2010, soil organic carbon (SOC) increased by 10.3 - 57.6 % in 2009 and 10.0 – 57.0 % in 2011 under different treatments, respectively. But in wheat season, soil pH was significantly increased by 0.11-0.24 units in 2010 and 0.09-0.24 units in 2011, CaCl2 extracted Cd in soil decreased by 10.1- 40.2% in 2010 and 1.80 - 23.1 % in 2011, soil organic carbon (SOC) increased by 10.0 - 57.0 % in 2010 and 9.4 - 42.3 % in 2011 under different treatments. After BC amendment, rice grain Cd concentration was observed to be reduced by 16.8 - 45.0 % in 2009 and 39.9 - 61.9 % in 2010, while the total plant Cd uptake was found to decrease by 28.1 - 54.2 % in 2009 and 14.4 - 45.9 % in 2010, respectively. The wheat grain Cd concentration was observed to be reduced by 24.8 - 44.2 % in 2010 and 14.0 -39.2 % in 2011, total wheat Cd uptake was decreased by 16.8 -37.3 % in 2010 and 6.5 - 28.3 % in 2011. The same trends were also observed on different tissues of rice and wheat. Such effect of BC amendment on reducing Cd plant uptake has profound implications, not only was useful in the rice season, but also could be used in dry-land of the wheat season and the effect of the biochar on crops were sustainable for at least two consecutive rice - wheat rotation seasons without BC reapplication. Finally, BC amendment offers a basic option to reduce heavy metals level in crops as well as to increase the sequestration of soil carbon in agriculture in contaminated paddies.