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INVESTIGATIONS INTO THE EFFECTS OF Cd (CADMIUM) STRESS ON *SPINACEA OLERACEA* AND RETENTION PROPERTIES IN SOIL IN RESPONSE TO COW DUNG AND CHARCOAL AMENDMENTS

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Background

With the increase in industrialization, the contaminants emerging from anthropogenic activities have deteriorated the quality of fresh and wastewater resources. Cadmium is a heavy metal which increased significantly in natural environment since last century due to inputs from application of fertilizers, municipal waste and industrial sludges. In higher concentration, Cd proved to be phytotoxic and is well known as carcinogen inducing tumors in humans in different body parts. In current study, the aim was to evaluate the kinetics of Cd in test plant Spinacea oleracea (commonly known as Spinach) in soil media in response to cow dung and charcoal. The objectives of the study were 1) To assess the effect of Cd contaminated irrigation wastewater on Spinach plant and its kinetics in soil. 2) Mitigate the Cd toxicity in test plant using organic amendments namely cow dung and charcoal.

Methods

In this study, spinach plant was grown in earthen pots with application of cadmium (Cd) contaminated irrigation wastewater. The impacts of Cd stress on soil and plants were assessed using different physio-chemical analysis after di-acid digestion of herbage and soil samples. Two organic amendments namely cow dung and wood charcoal from *Vachellia karroo* wood were mixed into soil (2 kg) prior to sowing @ 20 and 30 t ha^{-1} to check the kinetics of Cd in soil and plants. Different treatments were control, metal alone, charcoal 20 Cd, Charcoal 30 Cd, cow

dung 20 Cd, and Cow dung 30 Cd. Sowing of seeds of spinach (7-8 in each pot) was done which after one week of germination were thinned to 5 plants per pot. The plants removed in thinning were mixed with soil in same pots. After three weeks of irrigation with tap water (without Cd), plants were applied with Cd contaminated synthetic wastewater @ 20 mL per week of 100 µM of Cd solution. After six weeks, plants were cut 5 cm above the soil. At harvest, soil was sampled along with roots and leaves. The Fourier Transform Infrared Spectroscopy (FTIR) analysis of charcoal was conducted from National University of Science and Technology, Islamabad. While the chemical analysis of herbage and soils were done in University of Agriculture, Faisalabad, Pakistan.

Results

The maximum plant fresh biomass was observed for treatment receiving 30 t ha^{-1} of charcoal (charcoal 30 Cd) followed by metal alone treatment @ 9.5 g pot^{-1}. The metal alone treatment gave the significant increased biomass yield that showed spinach affinity for Cd and good for remediation. The highest Cd concentration (0.116 mg kg^{-1}) in soil was found in treatment charcoal @ 30 t ha^{-1} with Cd while the lowest (0.10 mg kg^{-1}) was recorded in Cow dung @ 20 t ha^{-1}. In herbage, highest level (0.91 mg kg^{-1}) of Cd was in metal alone treatment. Lowest was recorded in treatment (0.016 mg kg^{-1}) with cow dung at higher level i.e. 30 t ha^{-1}. Therefore, cow dung immobilize the Cd in soil and reduce its uptake by Spinach. The Organic carbon content was determined by muffle furnace in different post harvest soils and was found highest in charcoal treatment (0.034 mg g^{-1}) at 30 t ha^{-1}. The temperature at the pot trial green house was about 30 ^{0}C while no rainfall water was allowed to enter into the pots. The FTIR analysis of charcoal was conducted that showed peaks at 2250, 1000 and 2000 cm^{-1} showing C-C, C=C and C-O-C bonding, respectively. In batch sorption study, the Langmuir Isotherm showed correlation value of 0.862. The value of q_{max} was recorded 12.34 mg g^{-1} at the highest dose of 30 ppm Cd influent concentration.

Conclusion

Cow dung proved to be more helpful as an amendment to stabilize Cd in soil and reducing its uptake in spinach significantly than charcoal. The laboratory batch study confirmed the sorption of Cd on cow dung and therefore, it can be considered as cost effective strategy for bioremediation of contaminated soils and added value for wastewater treatment.