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Effects of Biochar on Berseem Clover (Trifolium alexandrinum, L.) Growth and Heavy Metal (Cd, Cu, Pb, and Ni) Accumulation

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Introduction

The cultivation of urban soils can represent a good alternative for the food supply, but soil pollution by heavy metals (HMs) is one of the critical point for their use because they often exceed the tolerable limits. This study aims aimed at producing fodder crops from HM-polluted soil used for urban and allotment purposes following treatment with biochar.

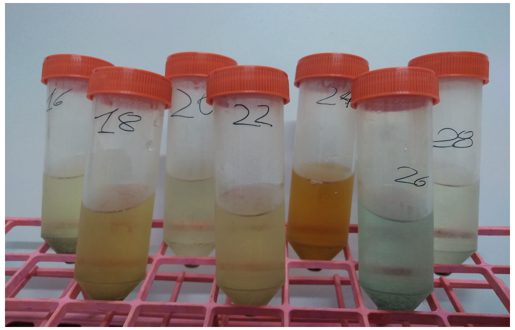
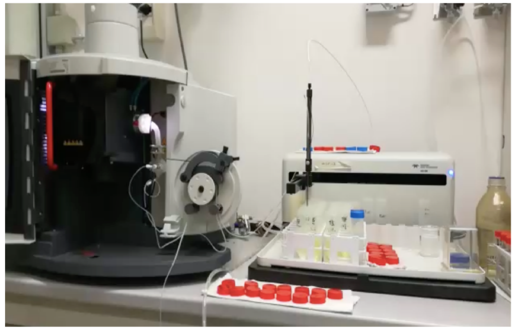
Materials and Methods

The study was carried out from July 1st, 2019 to October 30th, 2019. The soil was sandy with near-neutral pH and it was polluted by copper (Cu) and lead (Pb) based on Italy, European Union and other countries limits, while having cadmium (Cd) and nickel (Ni) concentrations just below the limit. Biochar was obtained from a mix of Douglas (*Pseudotsuga menziesii,* Mirb.) and Black Pine (*Pinus nigra*, J.F.Arnold) wood. Three different substrates were prepared: a control substrate constituted by 100% of the contaminated soil (labeled with C) and two substrates constituted by the contaminated soil amended with biochar at a rate of 0.8% w/w (labeled with B) and the rate of 1.6% w/w (labeled with BB letter). A pot trial was carried out in a climatic chamber. Seeds of beersem clover (*Trifolium alexandrinum*, L.) were sown at 30 kg ha^{-1}. On RStudio a one-way ANOVA was performed to assess statistically significant differences among treatments. Post-hoc Tukey's test was performed to show significant differences ($p<0.05$) among different means.



Results

Biomass dry weight (DW) in the BB treatments was significantly higher than those of B and C treatments both for aboveground and root tissues, but no significant increase in DW was measured in B compared to that of the C treatment (Table 1). The Cd concentration in above-ground tissues was not significantly influenced by biochar addition (Table 2), while Cu significantly decreased from C through to BB by about 16.6% and 16.7%, respectively, with B treatment showing an intermediate behavior. Ni and Pb concentrations were significantly lower in BB treatment than C, by about 37% and 12%, respectively.

Plant part	Biomass dry weight (kg m^{-2})		
	C	B	BB
Above ground tissues	0.76 ± 0.10 B	0.88 ± 0.10 B	1.05 ± 0.10 A
Roots	0.09 ± 0.02 B	0.10 ± 0.01 B	0.13 ± 0.02 A

Table 1: Average and standard deviation (SD) of dry weight (DW) for aboveground tissues and roots

HM	HM concentration in above-ground tissues (mg kg^{-1})		
	C	B	BB
Cd	1.49 ± 0.08	1.44 ± 0.07	1.42 ± 0.14
Cu	108.02 ± 11.38 A	97.40 ± 9.16 AB	90.01 ± 8.15 B
Ni	18.79 ± 3.83 A	17.94 ± 4.04 A	11.80 ± 2.6 B
Pb	14.95 ± 1.30 A	14.70 ± 0.26 A	13.19 ± 1.06 B

Table 2: Average and standard deviation (SD) of heavy metals (HM) concentration in aboveground tissues

Conclusions

Biochar positively affected the growth of berseem clover by increasing the DW production of both aboveground and root tissues. Biochar significantly reduced the concentration of Cu, Ni, and Pb in the aboveground tissues of berseem clover, whilst the reduction of Cd was not significant. Results indicate that berseem clover can be considered a Cd, Ni, and Pb excluder, while it was shown to be suitable for Cd phytoextraction and phytostabilization.

Pescatore, A., Grassi, C., Rizzo, A. M., Orlandini, S., & Napoli, M. (2021). Effects of biochar on berseem clover (Trifolium alexandrinum, L.) growth and heavy metal (Cd, Cr, Cu, Ni, Pb, and Zn) accumulation. *Chemosphere*, 131986.
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