Phytomanagement solutions for Cd-Pb contaminated garden soils: results of field and pot experiments

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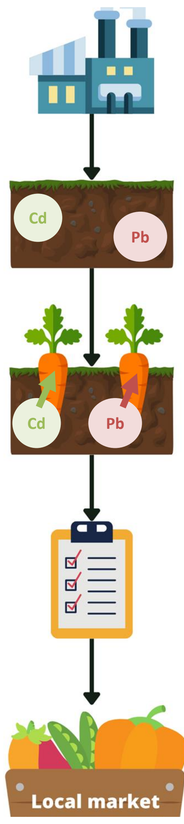
Background



Past industrial activities in central Belgium have been responsible for large atmospheric deposition of metallic trace elements (TE) in the environment.

The commercialization of food products such as vegetables is subject to a European directive setting maximum levels for TE in foodstuffs.

Food safety has become a prominent public concern since transfers of metals such as Cd and Pb from soil to vegetables were observed in market gardens.

The research aims to identify remediation strategies allowing a safe production of vegetables in areas impacted by small atmospheric contaminations.

Research questions

We investigated :

1. The effects of intercropping high biomass crops to vegetables on soil-plant transfers

2. The effects of biochar, green waste compost and lime addition on soil properties and trace element uptake by Swiss chard (*Beta vulgaris* L. subsp. vulgaris)

Methods

Phase 1

Pot experiment 5 kg of soil + Field experiment 5 plots

Biochar (2 kg/m²) or green waste compost (5 kg/m²) addition

+

Sunflower or Indian mustard and Swiss chard intercropping

Cd – Pb uptake by Swiss chard
Soil $CaCl_2$ extractible TE and pH



Phase 2

Continued pot experiment

Repeated biochar or greenwaste compost application + Lime addition (0 – 1 – 2 g/5 kg)

Soil properties of the plots

Zone	Cd (mg/kg)			Pb (mg/kg)			pH	COT (%)	% clay
	Sol.	Avail.	Pseudo - tot.	Sol.	Avail.	Pseudo - tot.			
Plot 1	0,15	0,75	1,07	< LOQ	19,2	60	6,2	2,8	13,2
Plot 2	0,03	1,03	1,67	< LOQ	30,3	80	6,9	3,7	11,9
Plot 3	0,41	0,80	1,27	< LOQ	21,3	63	5,5	2,9	9,4
Plot 4	0,02	1,24	1,97	< LOQ	84,0	155	6,7	5,5	6,1
Plot 5	0,50	1,03	1,50	< LOQ	31,9	85	5,5	3,6	10,3

The soil used in the pot experiment is the same as from the plot 5.

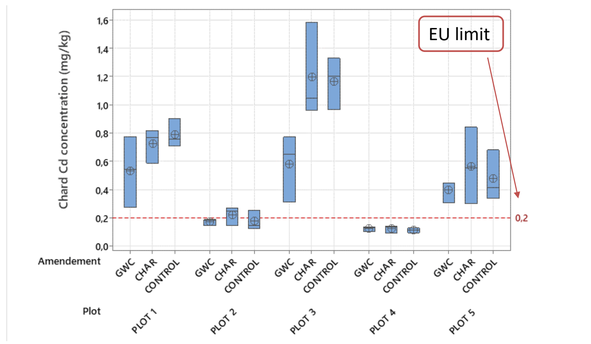
Results

Phase 1

Intercropping treatments

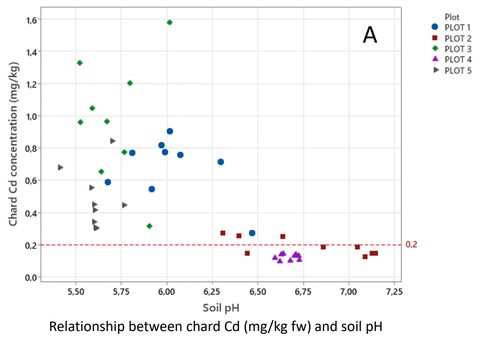
- Pot and field experiments: intercropping significantly decreased chard biomass compared to control.
- No significant impact of intercropping on element uptake by chard

Effects of addition of organic amendments on Cd and Pb uptake

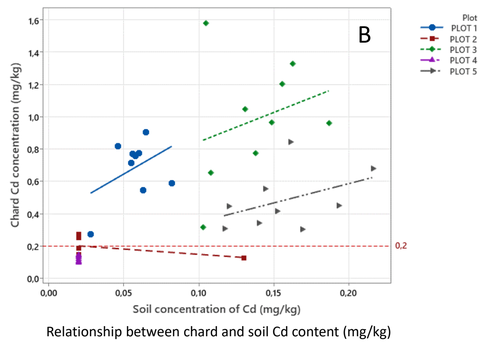


Effects of amendments addition on chard Cd concentration (mg/kg fw) in the five plots studied

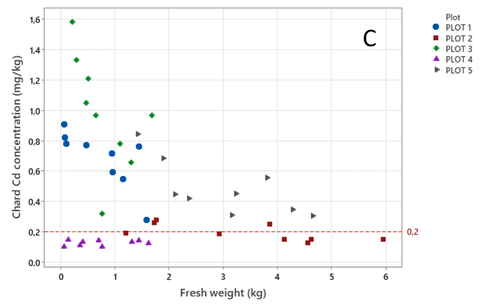
- Compost addition reduced the Cd concentration in chard
- No change observed on lead uptake
- No effect of biochar addition on plant content nor soil properties
- No observed effects in pots



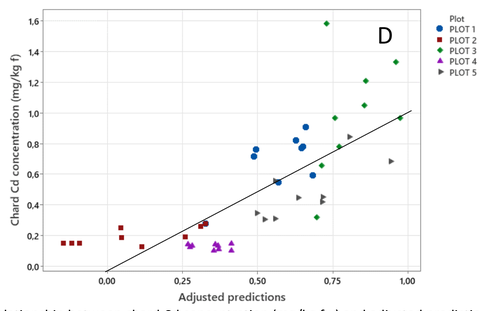
Relationship between chard Cd (mg/kg fw) and soil pH



Relationship between chard and soil Cd content (mg/kg)



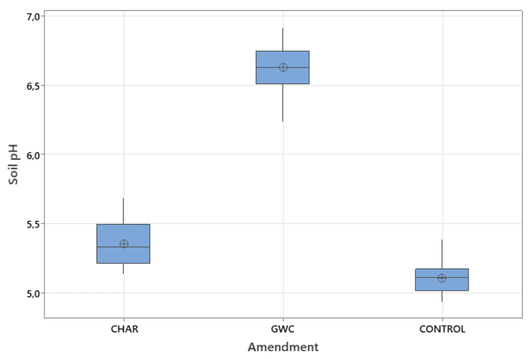
Relationship between chard Cd (mg/kg fw) and biomass production (kg)



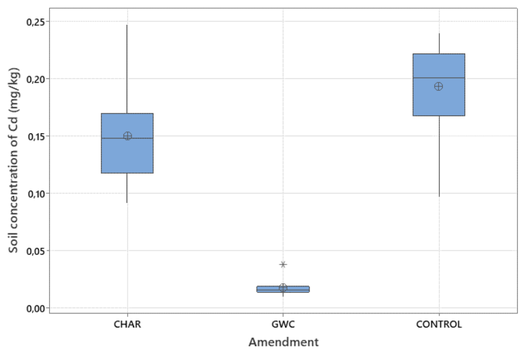
Relationship between chard Cd concentration (mg/kg fw) and adjusted predictions

- *In situ*: Cd plant concentration is linearly related to soil pH, $CaCl_2$ Cd content and plant biomass (see A, B, C)
- After regression modelling, 50% of chard Cd content is explained by these factors (see D).
- Chard growing on plots 2 and 4 almost comply to EU regulation, mainly because pH are higher than 6,5.

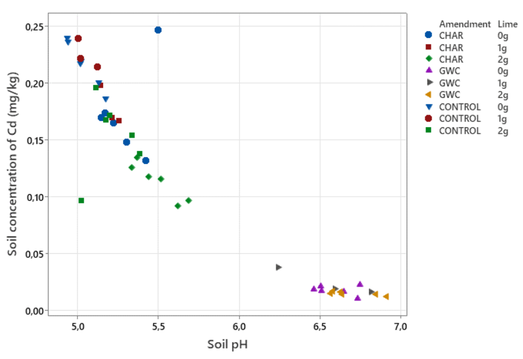
Phase 2



Box-plot depicting effects of amendments addition on soil pH



Box-plot depicting effects of amendments addition on soil Cd content (mg/kg)



Relationship between soil Cd (mg/kg) and pH according to treatments

- Soil $CaCl_2$ extractible Cd depends on pH unlike Pb.
- Compost addition significantly increased the soil pH and hence decreased the Cd concentration.
- Lime addition also contributed to pH increase but in a lesser extent than compost. Moreover, significant interaction between lime and other treatments was observed which impedes the drawing of general conclusions.
- No effects of treatments could be observed on Pb.

Conclusions

- Intercropping turned out not to be adapted to the context of the study, mainly due to competition effects.
- Soil pH seems to be the key lever to control Cd mobility.
- Compost addition was the most effective solution to increase pH and reduce soil and plant Cd content. However the quality of the compost is crucial in regards to this process.
- No significant results were found for Pb content.

Perspectives

- Phase 2: harvest of chard expected
- Continue field trials to study the impact of organic amendments additions in the long term.
- Further studies are still needed to identify remediation strategies for Pb and for other crops.