

Phytoremediation of cadmium-contaminated *Coffea arabica* coffee-growing soils using *Moringa oleifera* in the Peruvian Andes

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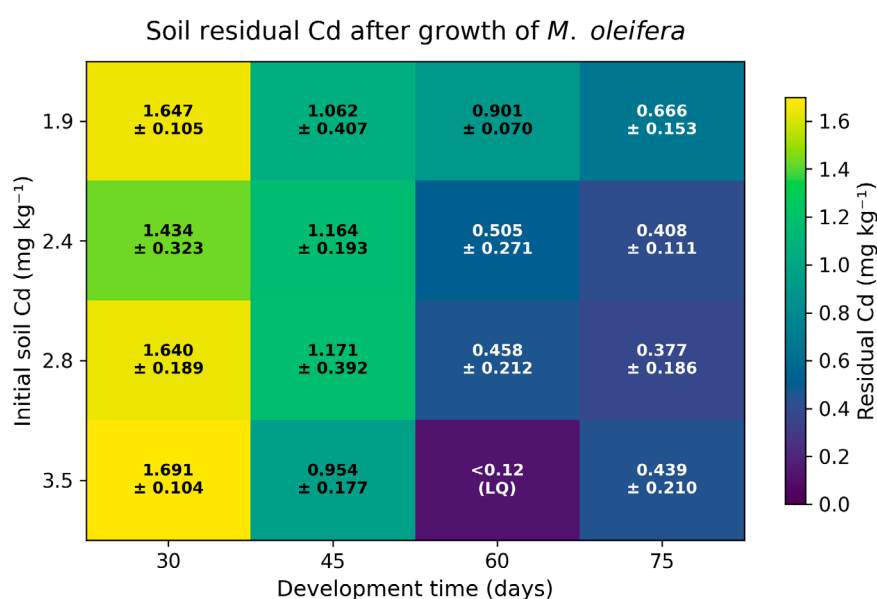
Supplementary material

Block 1				Block 2			
Cd 1.9 60 d	Cd 2.8 60 d	Cd 1.9 45 d	Cd 2.4 30 d	Cd 2.4 60 d	Cd 1.9 45 d	Cd 1.9 60 d	Cd 1.9 30 d
Cd 2.4 60 d	Cd 2.8 30 d	Cd 3.5 45 d	Cd 3.5 60 d	Cd 3.5 30 d	Cd 2.8 30 d	Cd 2.8 75 d	Cd 2.4 45 d
Cd 2.4 45 d	Cd 3.5 30 d	Cd 2.4 75 d	Cd 3.5 75 d	Cd 3.5 60 d	Cd 3.5 75 d	Cd 2.8 60 d	Cd 1.9 75 d
Cd 1.9 30 d	Cd 2.8 45 d	Cd 1.9 75 d	Cd 2.8 75 d	Cd 2.4 75 d	Cd 2.8 45 d	Cd 2.4 30 d	Cd 3.5 45 d
Independent randomisation within block				Independent randomisation within block			
Block 3				Block 4			
Cd 2.4 30 d	Cd 2.8 75 d	Cd 2.4 75 d	Cd 3.5 30 d	Cd 2.8 30 d	Cd 2.8 75 d	Cd 3.5 30 d	Cd 1.9 30 d
Cd 3.5 45 d	Cd 2.4 45 d	Cd 1.9 30 d	Cd 2.8 45 d	Cd 1.9 75 d	Cd 2.4 45 d	Cd 3.5 60 d	Cd 2.4 60 d
Cd 1.9 60 d	Cd 1.9 45 d	Cd 1.9 75 d	Cd 3.5 75 d	Cd 1.9 60 d	Cd 2.8 45 d	Cd 2.4 30 d	Cd 3.5 75 d
Cd 3.5 60 d	Cd 2.8 60 d	Cd 2.8 30 d	Cd 2.4 60 d	Cd 1.9 45 d	Cd 2.8 60 d	Cd 3.5 45 d	Cd 2.4 75 d
Independent randomisation within block				Independent randomisation within block			

Factors: initial Cd = 1.9, 2.4, 2.8 and 3.5 mg kg⁻¹. Time = 30, 45, 60 and 75 days.Experimental unit: pot with contaminated coffee-growing soil and one 12-day-old *Moringa oleifera* seedling.

Figure S1. Initial randomized distribution of the 4 × 4 factorial RCBD with four blocks

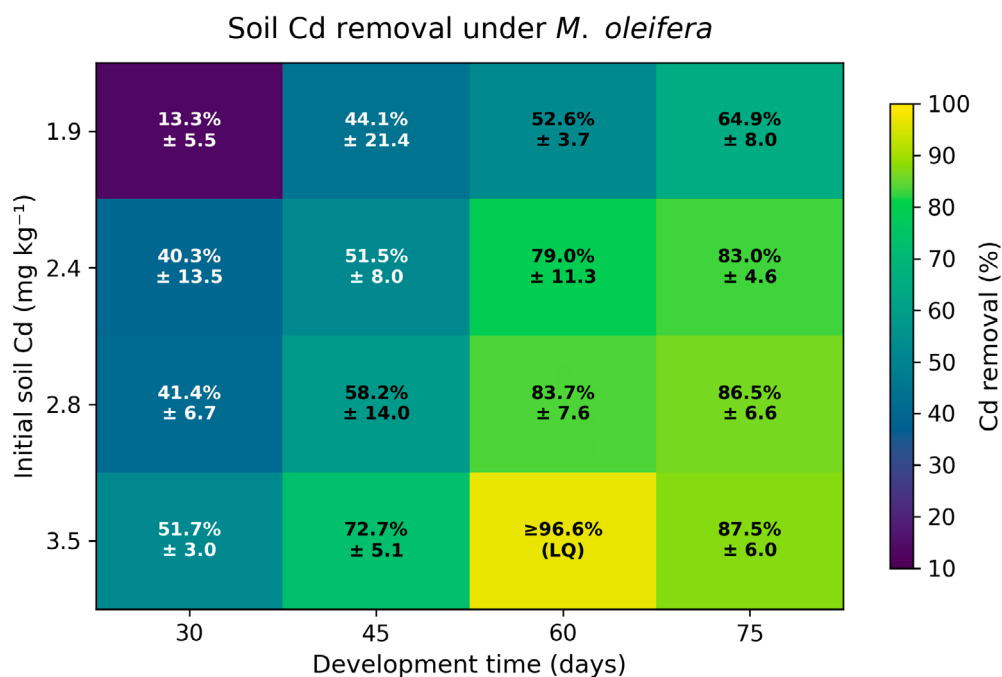
Note. Each block contains the 16 initial Cd × time combinations once, with independent randomization within block.



Each cell represents mean ± standard deviation, n = 4. The Peruvian EQS for agricultural soil is 1.4 mg kg⁻¹. LQ = 0.12 mg kg⁻¹.

Figure S2. Residual soil Cd by initial Cd level and development time





Each cell represents mean ± standard deviation, n = 4. LQ = 0.12 mg kg⁻¹.

Figure S3. Soil Cd removal by initial Cd level and development time

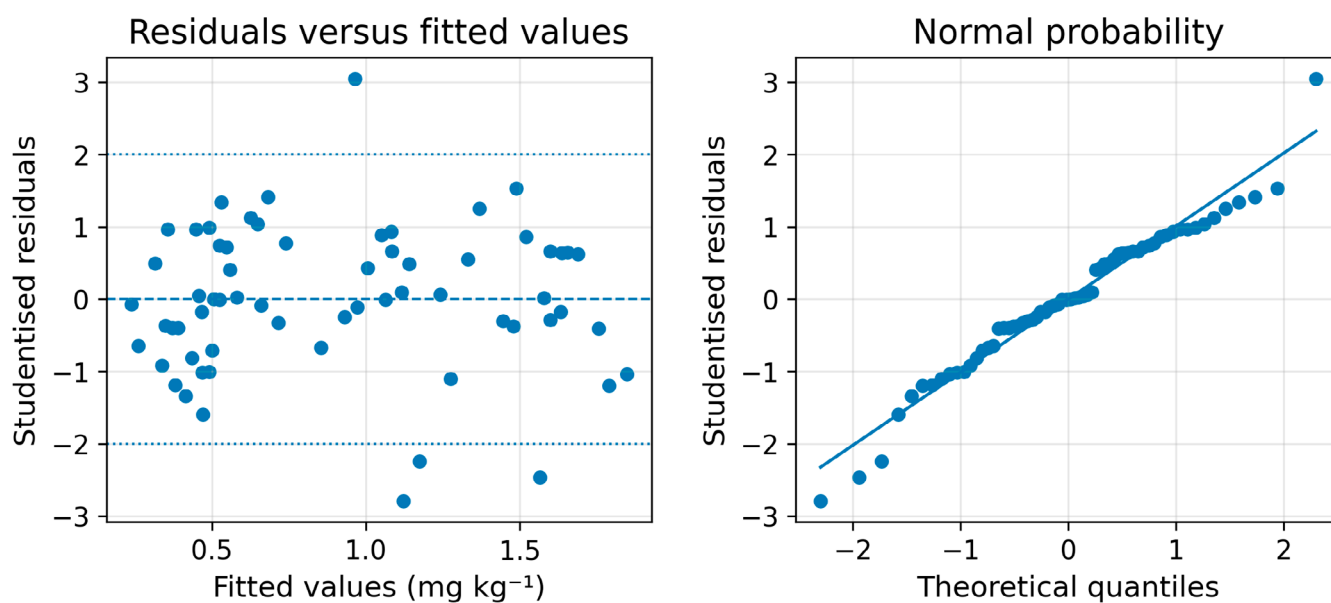
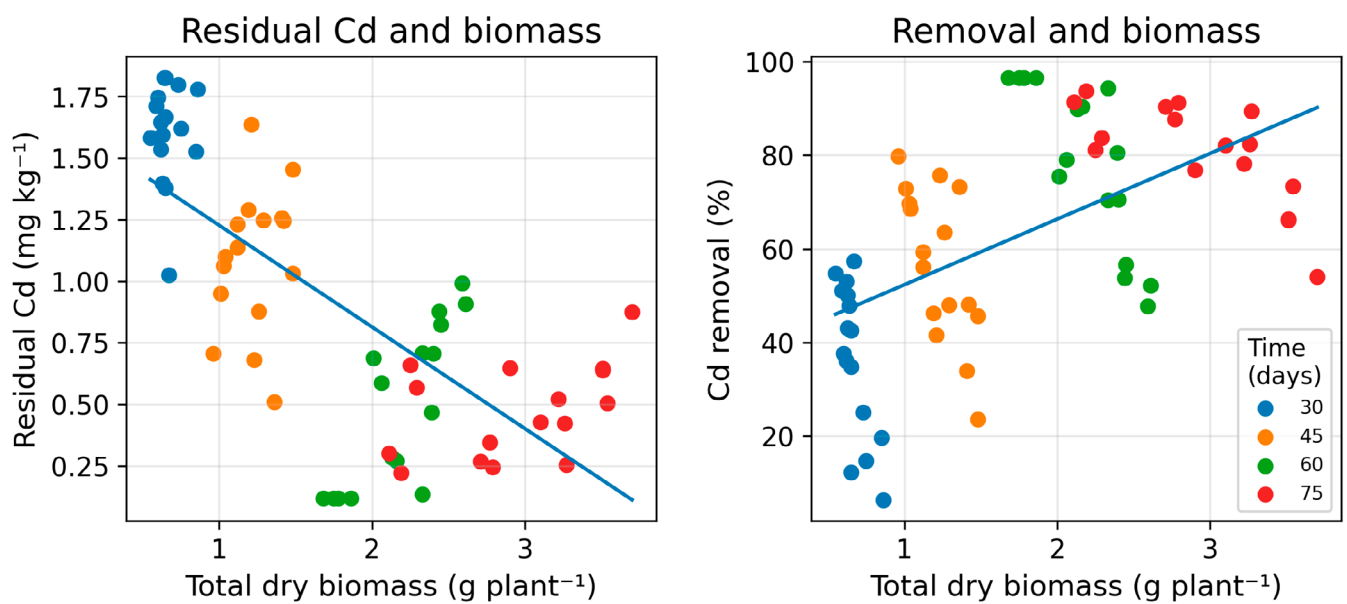


Figure S4. Graphical diagnostics of the general linear model for residual Cd

Table S1. Growth variables by development time

Time (days)	Total age (days)	Height (cm)	Stem thickness (mm)	Root length (cm)	Dry biomass (g plant ⁻¹)
30	42	24.37 ± 2.13	2.45 ± 0.22	12.42 ± 1.71	0.668 ± 0.087
45	57	35.97 ± 3.18	3.33 ± 0.29	16.84 ± 2.17	1.226 ± 0.171
60	72	47.59 ± 4.50	4.32 ± 0.39	20.94 ± 2.46	2.186 ± 0.303
75	87	57.20 ± 6.61	5.21 ± 0.58	22.66 ± 3.95	2.945 ± 0.527

Note. Values are mean ± standard deviation, n = 16 per development time.

**Figure S5.** Relationship between total dry biomass, residual Cd and Cd removal**Table S2.** Pearson correlations between remediation and growth variables

Relationship	r	p	Statistical reading
Residual Cd versus Cd removal	-0.912	<0.001	High negative association
Residual Cd versus plant height	-0.740	<0.001	High negative association
Residual Cd versus total dry biomass	-0.720	<0.001	High negative association
Cd removed versus total dry biomass	0.558	<0.001	Moderate positive association
Cd removed versus total dry biomass	0.263	0.036	Low positive association
Plant height versus total dry biomass	0.989	<0.001	High positive association
Stem thickness versus total dry biomass	0.990	<0.001	High positive association
Root length versus total dry biomass	0.937	<0.001	High positive association

Note. n = 64. Residual Cd was corrected by the conservative LQ substitution when applicable. Correlations describe association and do not establish causality or Cd allocation to plant organs.