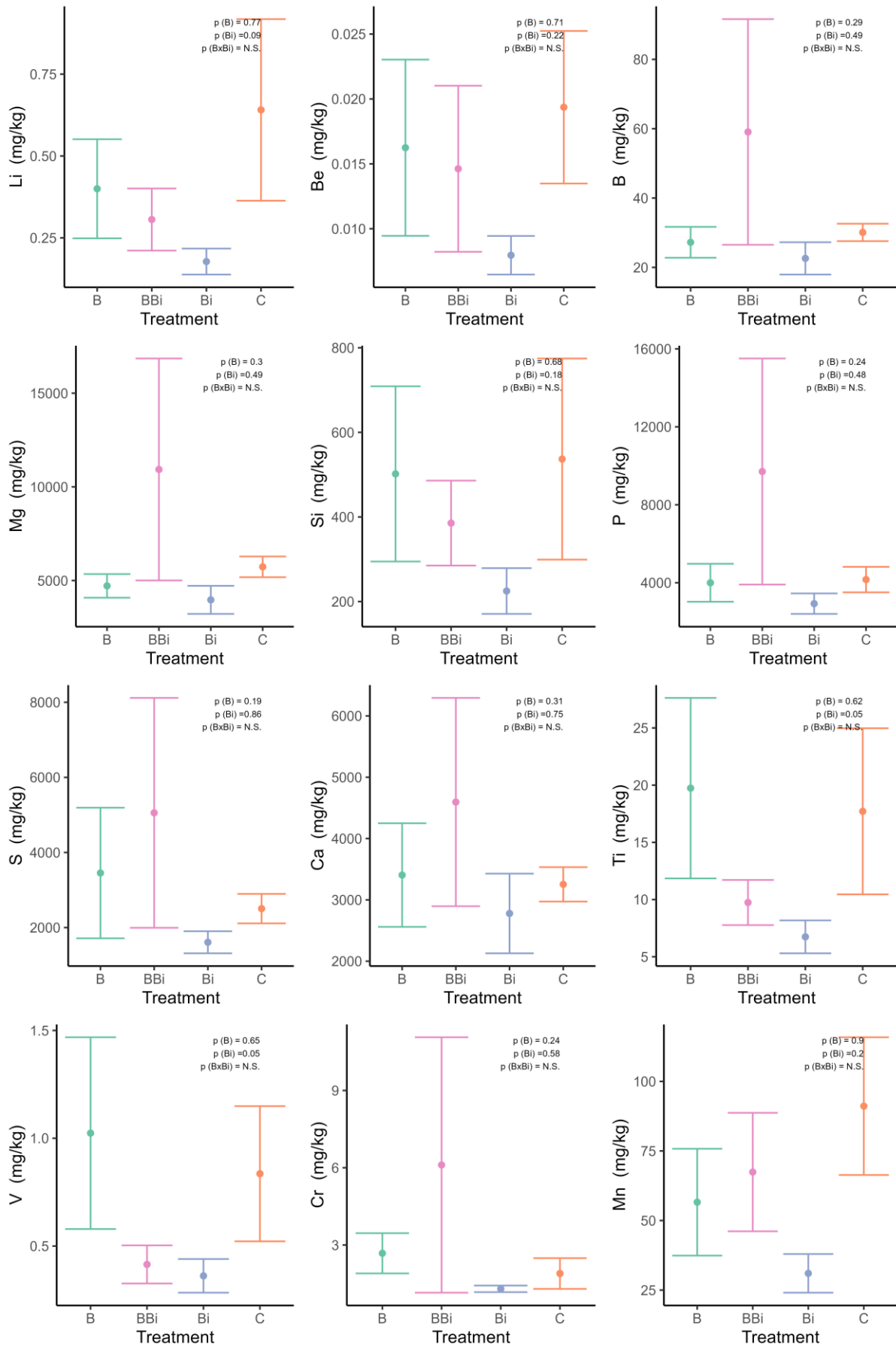


## S1. Timeline

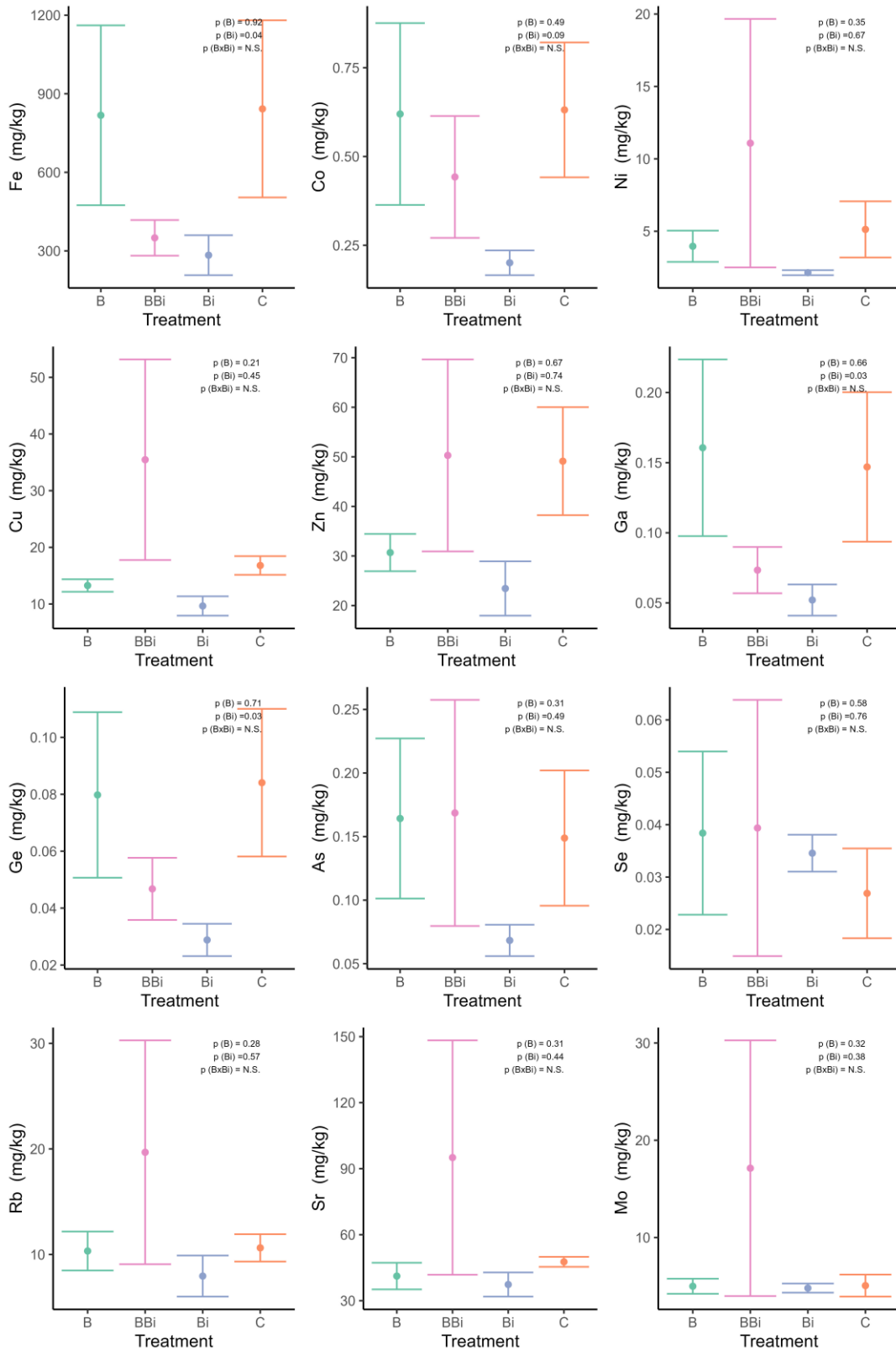
**Table S1:** Overview of the timeline of Belfast experiments.

	<b>Date</b>	<b>Clover plots</b>	<b>Mustard plots</b>
Summer (S1)	16-19 May 2023	Establish clover plots and seeding	
	16-19 May 2023	Clover soil sampling for testing in Antwerp (1)	
	monday 13 november 2023	<b>6-month clover biomass sample</b>	
Winter (W1)	monday 20 november 2023		Establish mustard plots and seeding
	friday 21 november 2025		CO2 gas emission tests begin on mustard plots
	saturday 20 december 2025	CO2 gas emission tests begin on clover plots	
	tuesday 7 mei 2024	<b>12-month clover biomass sample</b>	<b>6-month mustard biomass sample</b>
Summer (S2)	tuesday 12 november 2024	CO2 gas emissions tests end on clover plots	CO2 gas emission tests end on mustard plots
	tuesday 12 november 2024	Clover soil sampling for testing in Antwerp (2)	<b>12-month mustard biomass sample</b>

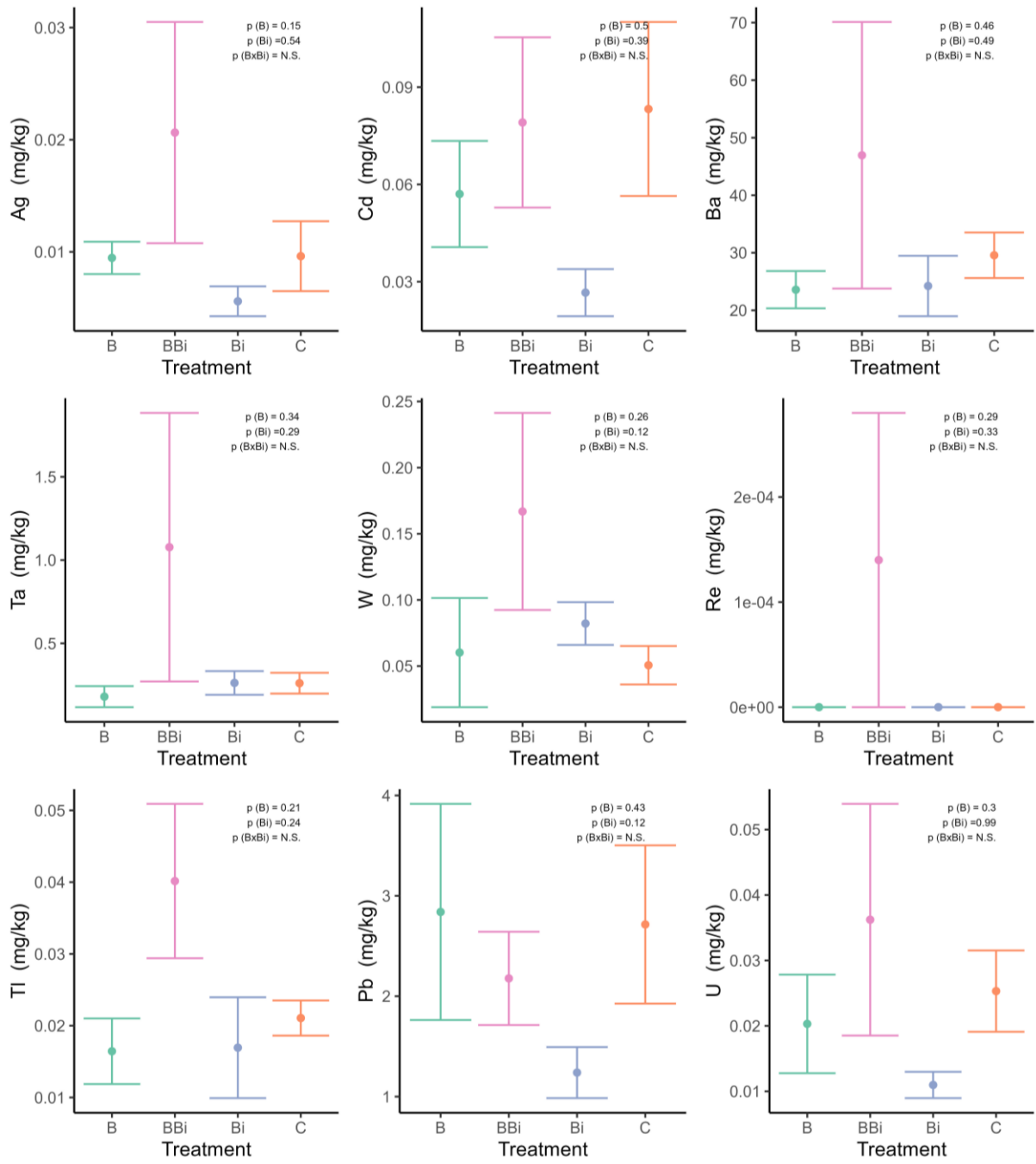
## S2. (Heavy) metals in plants and soil fractions



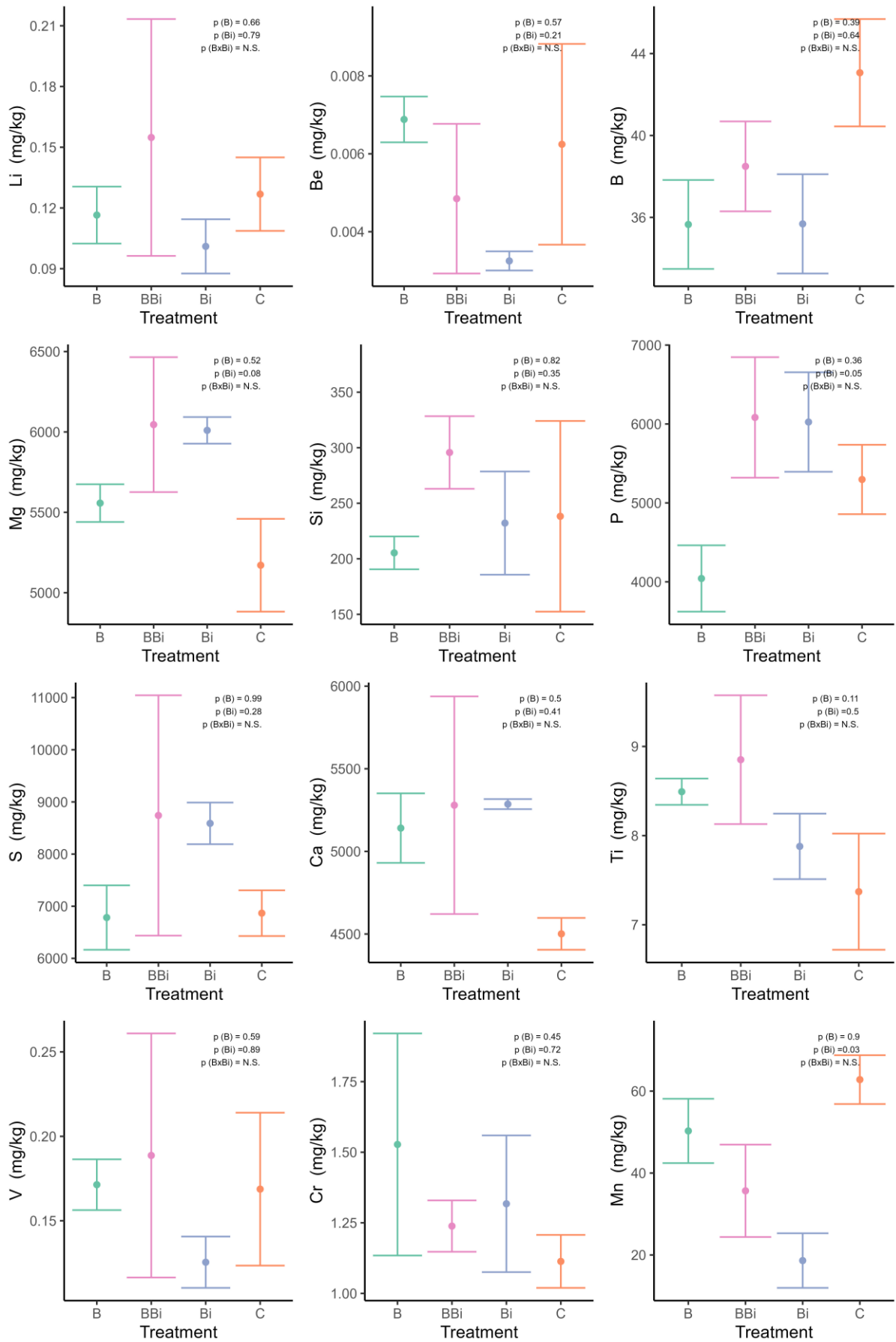
**Fig. S1:** Trace elements in clover plants. Significance of basalt p(B), biochar p(Bi) and interaction p(BxBi) are indicated on the figures. Dots and error bars represent averages and standard errors.



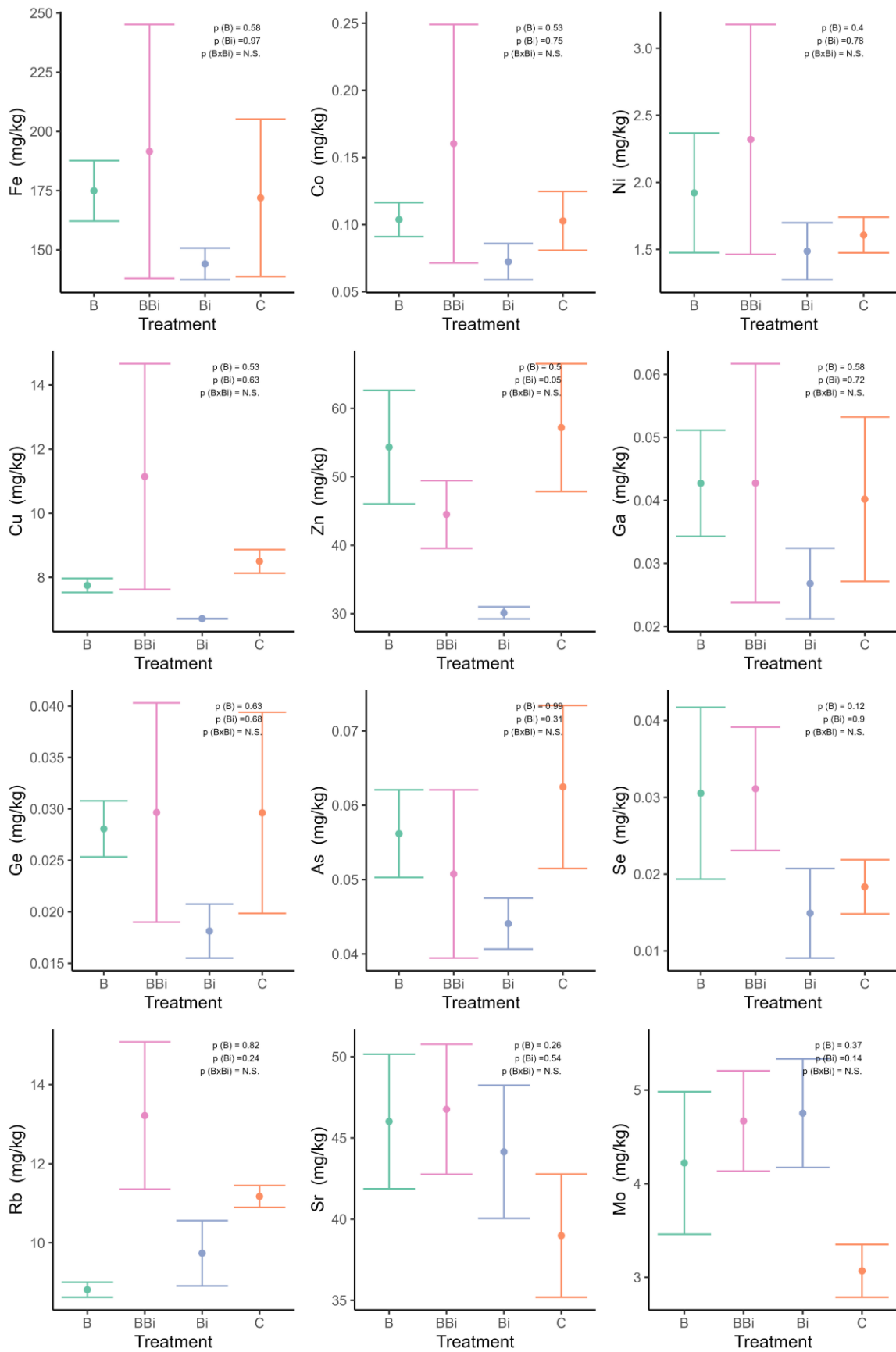
**Fig. S2:** Trace elements in clover plants. Significance of basal p(B), biochar p(Bi) and interaction p(BxBi) are indicated on the figures. Dots and error bars represent averages and standard errors.



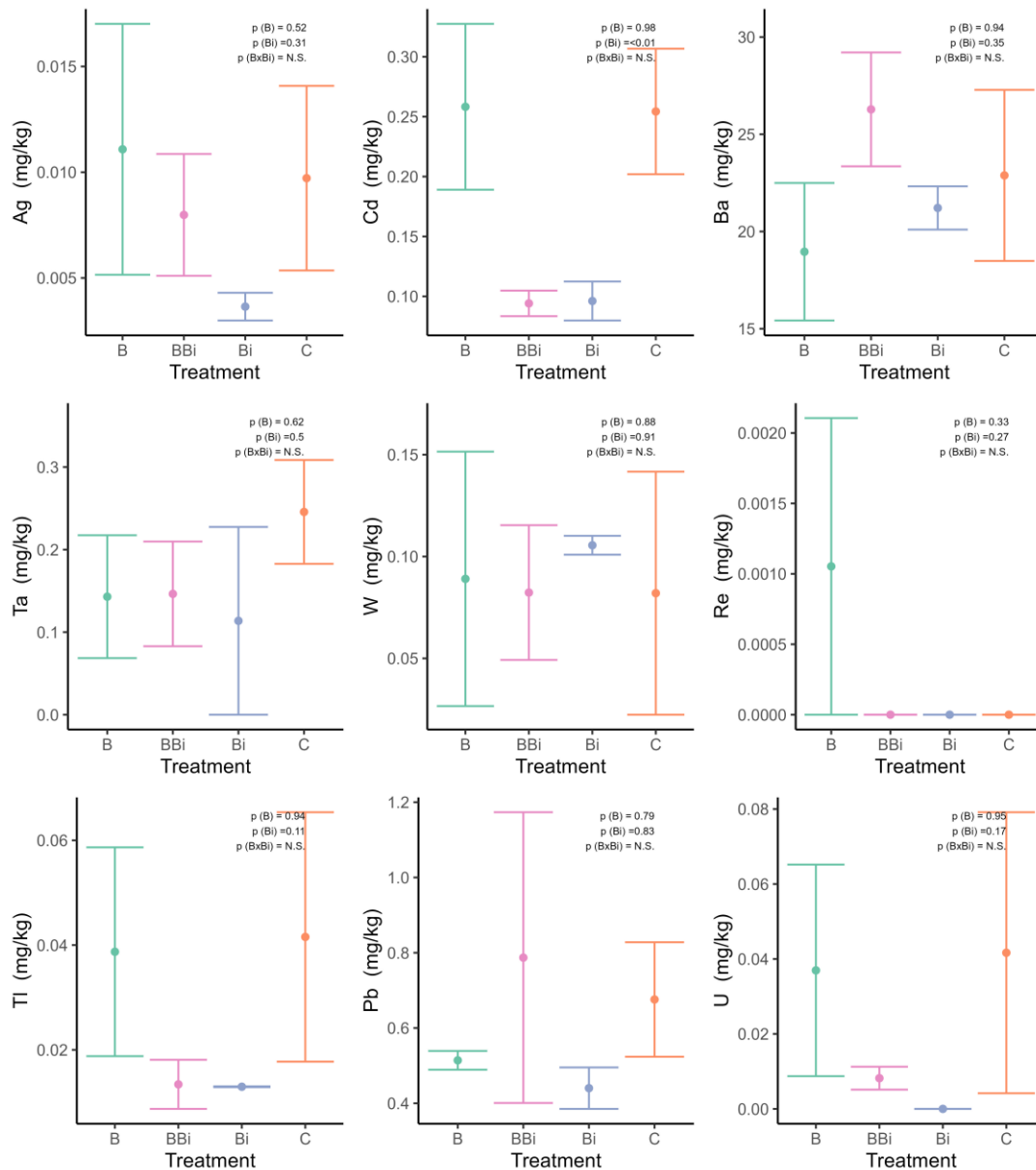
**Fig. S3:** Trace elements in clover plants. Significance of basal p(B), biochar p(Bi) and interaction p(BxBi) are indicated on the figures. Dots and error bars represent averages and standard errors.



**Fig. S4** : Trace elements in mustard plants. Significance of basalt p(B), biochar p(Bi) and interaction p(BxBi) are indicated on the figures. Dots and error bars represent averages and standard errors.



**Fig. S5:** Trace elements in mustard plants. Significance of basalt p(B), biochar p(Bi) and interaction p(BxBi) are indicated on the figures. Dots and error bars represent averages and standard errors.



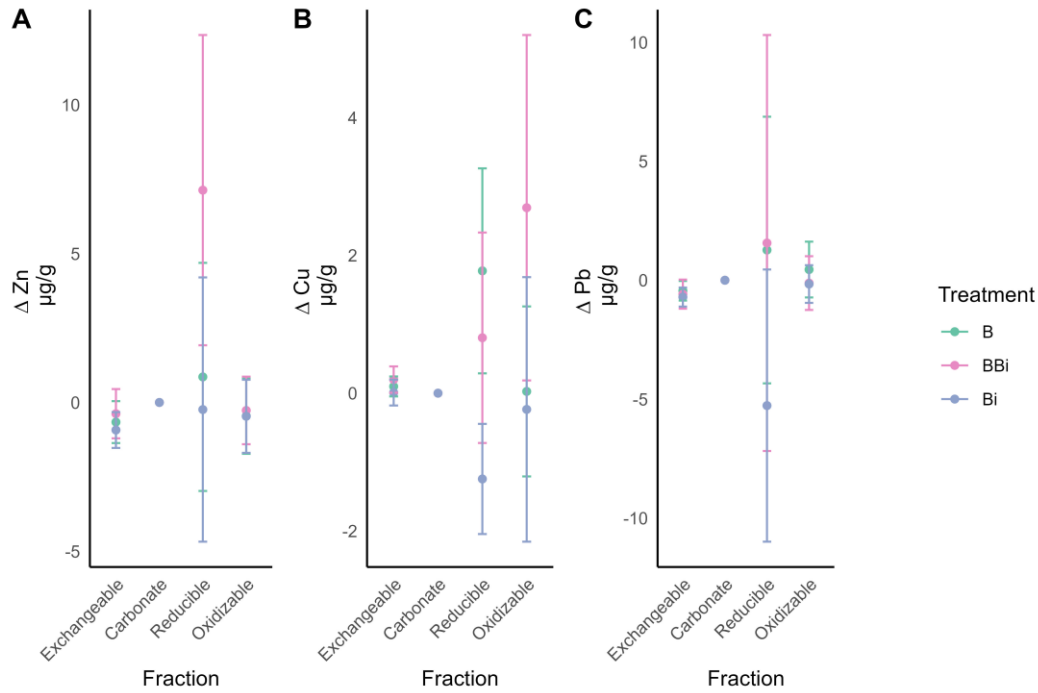
**Fig. S6:** Trace elements in mustard plants. Significance of basalt p(B), biochar p(Bi) and interaction p(BxBi) are indicated on the figures. Dots and error bars represent averages and standard errors.

In soils, we find that biochar amendment significantly decreased exchangeable Ni, while basalt significantly increased heavy metals (Ni and Cr) in the reducible soil fraction (which typically has low plant availability) (Table S2). Also reducible soil Cu tended to be higher after basalt amendment.

**Table S2:** Outcome of linear models for biochar, basalt (and interaction effects if any) as logical factors for elements in soil fractions (1 = exchangeable, 2= carbonate, 3= reducible and 4 = oxidizable). Significant effects are shown in bold. Samples were taken directly after amendment and 365 days later in clover planted plots. Carbonate elements were below detection limit and therefore are excluded from this table.

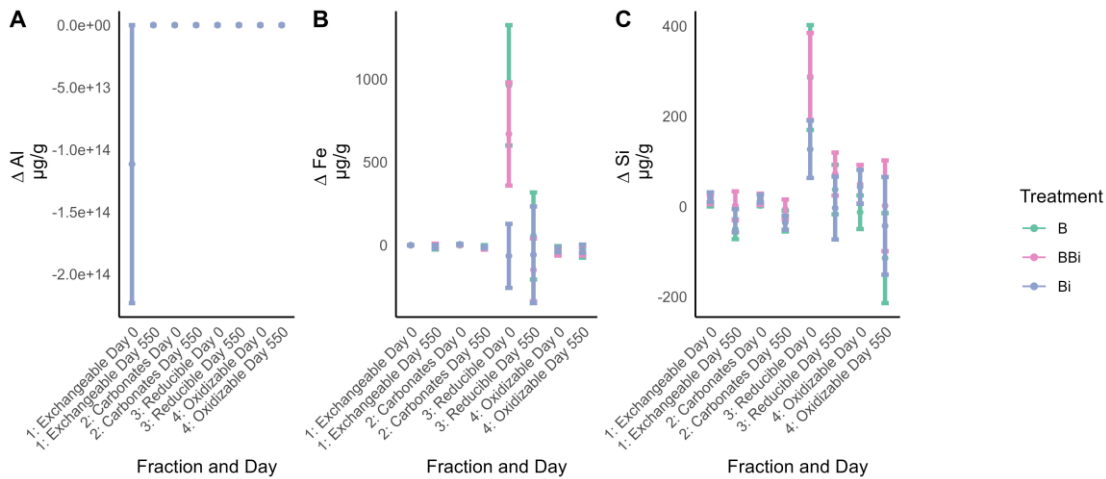
variables	effects	pvalues	element	fraction
Basalt (0/1)	-2.14e-02	0.8	Ni	1
<b>Biochar (0/1)</b>	<b>-1.79e-01</b>	<b>0.045</b>	<b>Ni</b>	<b>1</b>
Basalt x Biochar (0/1)	NA	N.S.	Ni	1
Basalt (0/1)	-1.43e-01	0.7	Pb	1
Biochar (0/1)	-4.08e-01	0.27	Pb	1
Basalt x Biochar (0/1)	NA	N.S.	Pb	1

variables	effects	pvalues	element	fraction
Basalt (0/1)	2.37e-02	0.33	Cr	1
Biochar (0/1)	2.37e-02	0.33	Cr	1
Basalt x Biochar (0/1)	NA	N.S.	Cr	1
Basalt (0/1)	-2.01e-02	0.97	Zn	1
Biochar (0/1)	-2.86e-01	0.57	Zn	1
Basalt x Biochar (0/1)	NA	N.S.	Zn	1
Basalt (0/1)	1.46e-01	0.29	Cu	1
Biochar (0/1)	5.69e-02	0.67	Cu	1
Basalt x Biochar (0/1)	NA	N.S.	Cu	1
<b>Basalt (0/1)</b>	<b>3.44e+00</b>	<b>0.037</b>	<b>Ni</b>	<b>3</b>
Biochar (0/1)	-6.19e-01	0.69	Ni	3
Basalt x Biochar (0/1)	NA	N.S.	Ni	3
Basalt (0/1)	4.21e+00	0.4	Pb	3
Biochar (0/1)	-2.32e+00	0.64	Pb	3
Basalt x Biochar (0/1)	NA	N.S.	Pb	3
Basalt (0/1)	<b>8.49e-01</b>	<b>&lt;0.01</b>	<b>Cr</b>	<b>3</b>
Biochar (0/1)	-2.28e-01	0.39	Cr	3
Basalt x Biochar (0/1)	NA	N.S.	Cr	3
Basalt (0/1)	4.31e+00	0.17	Zn	3
Biochar (0/1)	3.21e+00	0.3	Zn	3
Basalt x Biochar (0/1)	NA	N.S.	Zn	3
Basalt (0/1)	1.92e+00	0.077	Cu	3
Biochar (0/1)	-1.10e+00	0.29	Cu	3
Basalt x Biochar (0/1)	NA	N.S.	Cu	3
Basalt (0/1)	<b>6.43e-01</b>	<b>0.047</b>	<b>Ni</b>	<b>4</b>
Biochar (0/1)	-7.95e-02	0.79	Ni	4
Basalt x Biochar (0/1)	NA	N.S.	Ni	4
Basalt (0/1)	2.33e-01	0.77	Pb	4
Biochar (0/1)	-3.76e-01	0.64	Pb	4
Basalt x Biochar (0/1)	NA	N.S.	Pb	4
Basalt (0/1)	-2.19e-01	0.62	Cr	4
Biochar (0/1)	-1.39e-01	0.75	Cr	4
Basalt x Biochar (0/1)	NA	N.S.	Cr	4
Basalt (0/1)	-1.11e-01	0.89	Zn	4
Biochar (0/1)	-1.19e-01	0.88	Zn	4
Basalt x Biochar (0/1)	NA	N.S.	Zn	4
Basalt (0/1)	1.56e+00	0.31	Cu	4
Biochar (0/1)	1.30e+00	0.4	Cu	4
Basalt x Biochar (0/1)	NA	N.S.	Cu	4



**Fig. S7:** Delta in elements relative to control soils of Zn and Cu for the 4 different considered soil fractions. These soil elements were extracted after initial soil sampling in clover planted plots. Carbonate fraction Zn, Cu and Pb were below the detection limit.

For other soil metals, we did a second measurement 1 year after amendment (**Table 3**). Biochar increased exchangeable bases (Na, K and Mg) and also increased Ca, K and Na in the carbonate soil fraction (while decreasing Fe- and Al carbonates). Basalt also increased metals in the reducible pool here, namely Fe (**Figure 5**), Mg, K and Si, which suggest that amorphous clay (precursors) have been generated, that may have become unextractable at the last sampling. Oxidizable Al, Fe decreased for basalt, while basalt increased Mg and Na in this fraction.



**Fig. S8:** Delta in elements relative to control soils of Al, Fe and Si for the 4 different considered soil fractions. These soil elements were extracted after initial soil sampling and after 550 days in clover planted plots.

**Table S3:** Outcome of repeated measure linear models for biochar, basalt, time (and basalt x biochar interaction effects if any) as logical factors for elements in soil fractions (1 = exchangeable, 2 = carbonate, 3 = reducible and 4 = oxidizable). Significant effects are shown in bold. Samples were taken directly after amendment and 365 days later in clover planted plots.

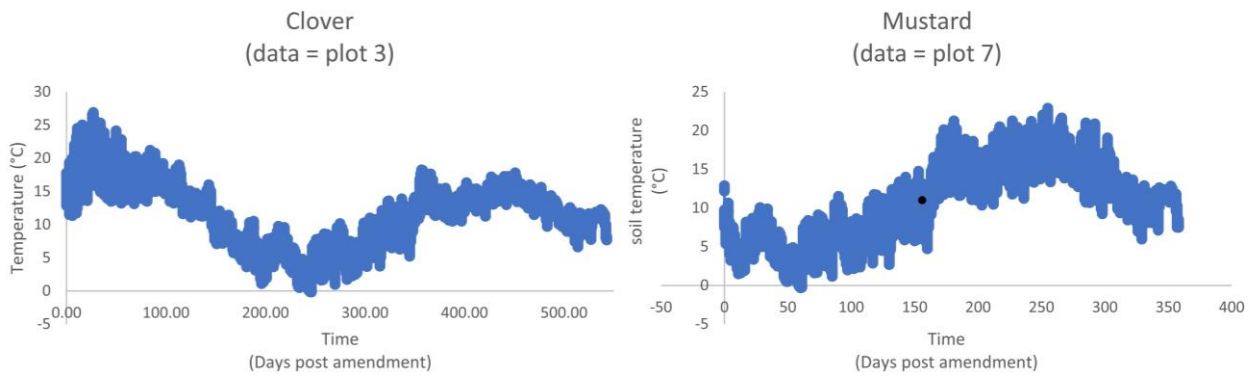
variables	effects	pvalues	element	fraction
Time (day)	1.54e-01	<0.01	Al	1
Basalt (0/1)	-1.47e+01	0.36	Al	1
Biochar (0/1)	-1.00e+01	0.97	Al	1
Basalt x Biochar (0/1)	1.98e+01	0.042	Al	1

variables	effects	pvalues	element	fraction
Time (day)	-1.76e+00	<0.01	Ca	1
<b>Basalt (0/1)</b>	<b>2.88e+02</b>	<b>0.046</b>	<b>Ca</b>	<b>1</b>
Biochar (0/1)	1.42e+02	0.33	Ca	1
Basalt x Biochar (0/1)	NA	N.S.	Ca	1
Time (day)	1.13e-01	<0.01	Fe	1
Basalt (0/1)	-3.39e+00	0.36	Fe	1
Biochar (0/1)	1.42e+00	0.7	Fe	1
Basalt x Biochar (0/1)	NA	N.S.	Fe	1
Time (day)	-1.29e+00	0.043	K	1
Basalt (0/1)	-1.61e+02	0.49	K	1
<b>Biochar (0/1)</b>	<b>6.50e+02</b>	<b>&lt;0.01</b>	<b>K</b>	<b>1</b>
Basalt x Biochar (0/1)	NA	N.S.	K	1
Time (day)	-2.73e-01	0.037	Mg	1
Basalt (0/1)	5.08e+01	0.35	Mg	1
<b>Biochar (0/1)</b>	<b>1.32e+02</b>	<b>0.015</b>	<b>Mg</b>	<b>1</b>
Basalt x Biochar (0/1)	NA	N.S.	Mg	1
Time (day)	-5.87e-01	0.026	Na	1
Basalt (0/1)	-5.34e+01	0.58	Na	1
<b>Biochar (0/1)</b>	<b>2.16e+02</b>	<b>0.024</b>	<b>Na</b>	<b>1</b>
Basalt x Biochar (0/1)	NA	N.S.	Na	1
Time (day)	2.76e-01	<0.01	Si	1
Basalt (0/1)	-5.12e+00	0.63	Si	1
Biochar (0/1)	1.34e+01	0.21	Si	1
Basalt x Biochar (0/1)	NA	N.S.	Si	1
Time (day)	2.97e-01	<0.01	Al	2
Basalt (0/1)	-7.85e+00	0.047	Al	2
<b>Biochar (0/1)</b>	<b>-1.10e+01</b>	<b>&lt;0.01</b>	<b>Al</b>	<b>2</b>
Basalt x Biochar (0/1)	NA	N.S.	Al	2
Time (day)	5.58e-01	<0.01	Ca	2
Basalt (0/1)	6.78e+01	0.25	Ca	2
<b>Biochar (0/1)</b>	<b>1.25e+02</b>	<b>0.036</b>	<b>Ca</b>	<b>2</b>
Basalt x Biochar (0/1)	NA	N.S.	Ca	2
Time (day)	1.95e-01	<0.01	Fe	2
Basalt (0/1)	-5.02e+00	0.059	Fe	2
<b>Biochar (0/1)</b>	<b>-5.28e+00</b>	<b>0.047</b>	<b>Fe</b>	<b>2</b>
Basalt x Biochar (0/1)	NA	N.S.	Fe	2
Time (day)	-8.74e-02	0.18	K	2
Basalt (0/1)	-2.38e+00	0.92	K	2
<b>Biochar (0/1)</b>	<b>5.07e+01</b>	<b>0.031</b>	<b>K</b>	<b>2</b>
Basalt x Biochar (0/1)	NA	N.S.	K	2
Time (day)	6.30e-02	0.034	Mg	2
Basalt (0/1)	9.38e+00	0.38	Mg	2
Biochar (0/1)	2.64e+01	0.014	Mg	2

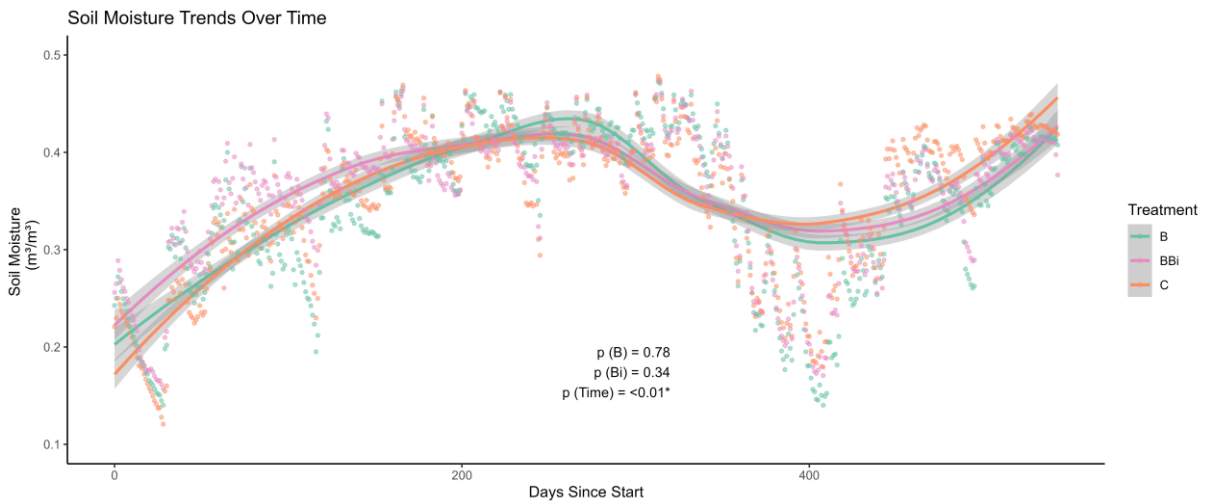
variables	effects	pvalues	element	fraction
Basalt x Biochar (0/1)	NA	N.S.	Mg	2
Time (day)	-6.07e-02	<0.01	Na	2
Basalt (0/1)	7.34e-01	0.91	Na	2
<b>Biochar (0/1)</b>	<b>1.38e+01</b>	<b>0.031</b>	<b>Na</b>	<b>2</b>
Basalt x Biochar (0/1)	NA	N.S.	Na	2
Time (day)	4.48e-01	<0.01	Si	2
Basalt (0/1)	-7.84e-01	0.93	Si	2
Biochar (0/1)	5.08e+00	0.57	Si	2
Basalt x Biochar (0/1)	NA	N.S.	Si	2
Time (day)	-3.37e-01	<0.01	Al	3
Basalt (0/1)	4.79e+01	0.12	Al	3
Biochar (0/1)	-3.23e+01	0.3	Al	3
Basalt x Biochar (0/1)	NA	N.S.	Al	3
Time (day)	-1.13e+00	<0.01	Ca	3
Basalt (0/1)	2.35e+02	0.12	Ca	3
Biochar (0/1)	1.31e+02	0.39	Ca	3
Basalt x Biochar (0/1)	NA	N.S.	Ca	3
Time (day)	-2.17e+00	<0.01	Fe	3
<b>Basalt (0/1)</b>	<b>4.01e+02</b>	<b>0.013</b>	<b>Fe</b>	<b>3</b>
Biochar (0/1)	-1.70e+02	0.29	Fe	3
Basalt x Biochar (0/1)	NA	N.S.	Fe	3
Time (day)	-1.68e-01	0.053	K	3
Basalt (0/1)	1.76e+01	0.58	K	3
Biochar (0/1)	5.92e+01	0.06	K	3
Basalt x Biochar (0/1)	NA	N.S.	K	3
Time (day)	-7.73e-01	0.044	Mg	3
<b>Basalt (0/1)</b>	<b>3.26e+02</b>	<b>0.019</b>	<b>Mg</b>	<b>3</b>
Biochar (0/1)	5.03e+01	0.72	Mg	3
Basalt x Biochar (0/1)	NA	N.S.	Mg	3
Time (day)	-7.02e-02	0.022	Na	3
Basalt (0/1)	1.15e+01	0.3	Na	3
Biochar (0/1)	1.94e+01	0.081	Na	3
Basalt x Biochar (0/1)	NA	N.S.	Na	3
Time (day)	-5.93e-01	<0.01	Si	3
<b>Basalt (0/1)</b>	<b>1.35e+02</b>	<b>&lt;0.01</b>	<b>Si</b>	<b>3</b>
Biochar (0/1)	3.54e+01	0.44	Si	3
Basalt x Biochar (0/1)	NA	N.S.	Si	3
Time (day)	2.36e-01	0.018	Al	4
<b>Basalt (0/1)</b>	<b>-7.98e+01</b>	<b>0.027</b>	<b>Al</b>	<b>4</b>
Biochar (0/1)	-1.04e+01	0.77	Al	4
Basalt x Biochar (0/1)	NA	N.S.	Al	4
Time (day)	-1.03e-01	0.28	Ca	4
Basalt (0/1)	3.43e+01	0.42	Ca	4

variables	effects	pvalues	element	fraction
Biochar (0/1)	7.38e+01	0.083	Ca	4
Basalt x Biochar (0/1)	NA	N.S.	Ca	4
Time (day)	2.87e-01	<0.01	Fe	4
<b>Basalt (0/1)</b>	<b>-2.51e+01</b>	<b>0.028</b>	<b>Fe</b>	<b>4</b>
Biochar (0/1)	-1.34e+01	0.24	Fe	4
Basalt x Biochar (0/1)	NA	N.S.	Fe	4
Time (day)	6.72e-02	<0.01	K	4
Basalt (0/1)	1.23e+00	0.87	K	4
Biochar (0/1)	1.17e+01	0.11	K	4
Basalt x Biochar (0/1)	NA	N.S.	K	4
Time (day)	-1.42e-01	0.081	Mg	4
<b>Basalt (0/1)</b>	<b>6.09e+01</b>	<b>0.042</b>	<b>Mg</b>	<b>4</b>
Biochar (0/1)	4.41e+01	0.14	Mg	4
Basalt x Biochar (0/1)	NA	N.S.	Mg	4
Time (day)	7.41e-02	<0.01	Na	4
<b>Basalt (0/1)</b>	<b>6.94e+00</b>	<b>0.048</b>	<b>Na</b>	<b>4</b>
Biochar (0/1)	6.40e+00	0.068	Na	4
Basalt x Biochar (0/1)	NA	N.S.	Na	4
Time (day)	5.02e-01	<0.01	Si	4
Basalt (0/1)	-2.99e+01	0.49	Si	4
Biochar (0/1)	3.40e+01	0.43	Si	4
Basalt x Biochar (0/1)	NA	N.S.	Si	4

### S3. Temperature and soil moisture



**Fig. S9:** Continuous temperature profile of the clover (left) and mustard (right) plots. Daily fluctuations are shown as vertical dotted ranges.

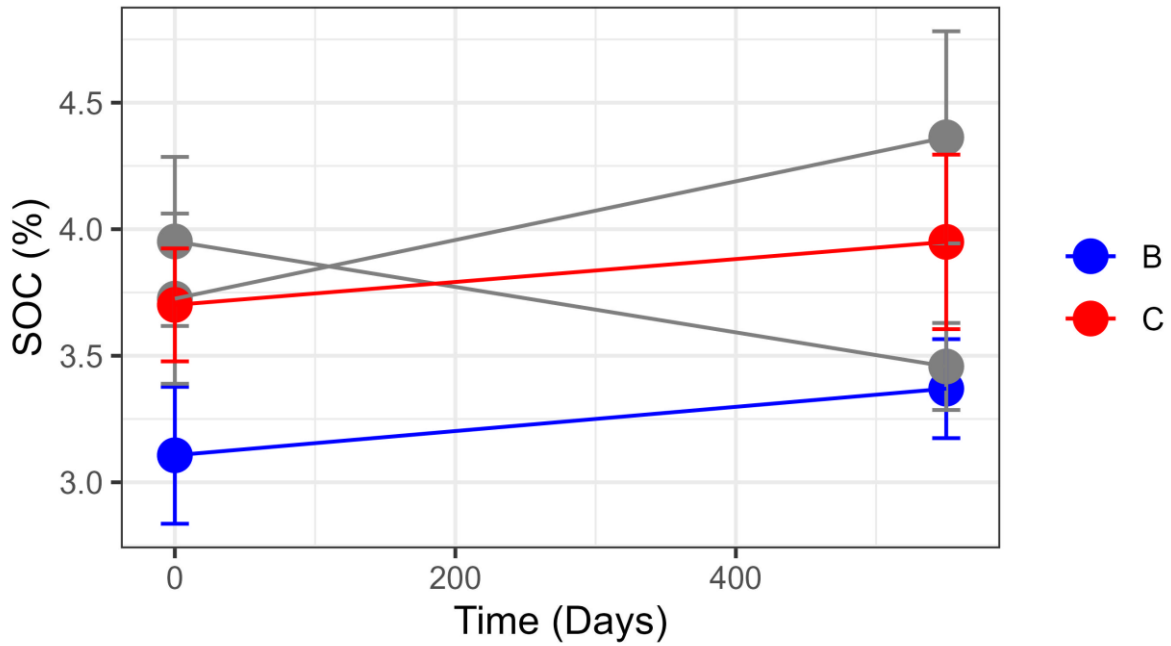


**Fig. S10:** Soil moisture profile in time for clover planted plots: datapoints with a loess smoother and statistical result of multiple linear repeated measures modelling.

### S4. Loss on ignition

From **Figure 11** can be derived that the SOC change in time (red and blue slope) was similar for control and basalt soil. Significant different slopes in SOC changes among treatments could thus not be identified from LOI (N= 20 at each date) in this relatively short-term experiment.

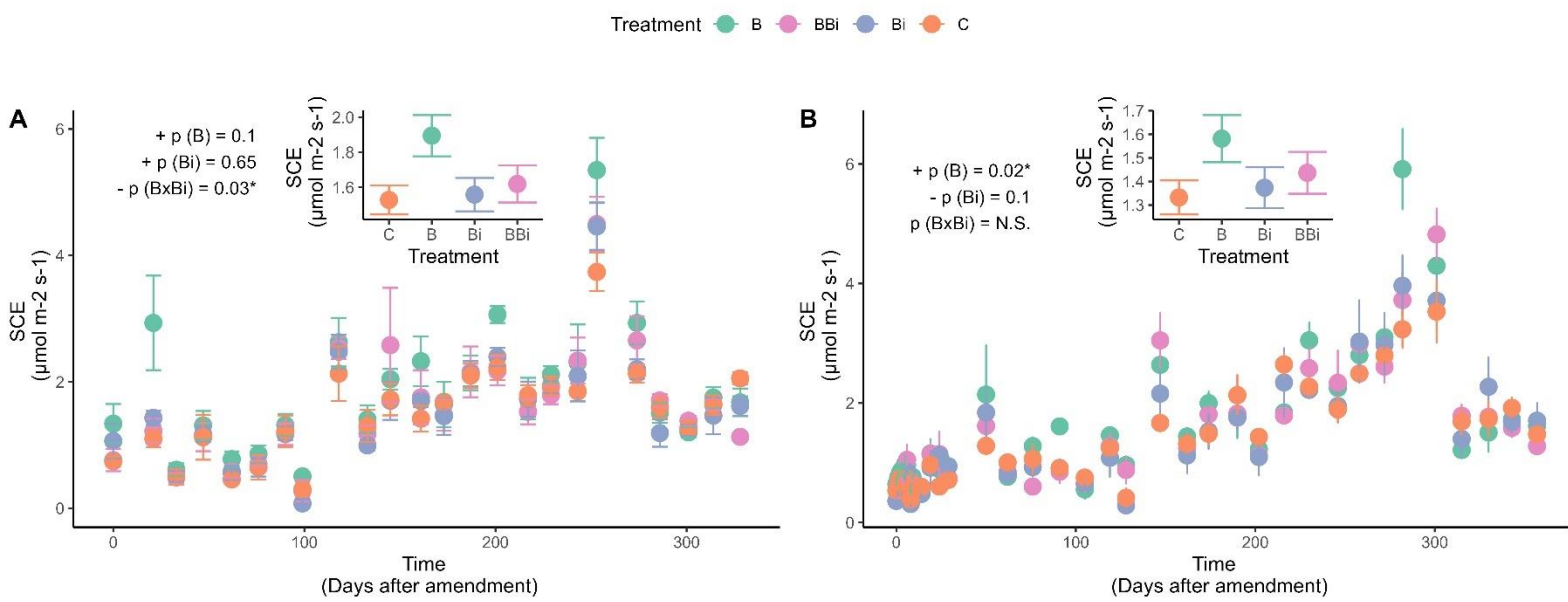
## SOC Percent Over Time (Belfast)



**Fig. S11:** SOC in clover plots (derived from LOI assuming 58% C in Soil organic matter) in function of time for basalt (blue) and controls (red). Biochar treatments are left in grey as results are expected to be heavily influenced from the amount of biochar in the sample and therefore unreliable.

**Table S4:** Particle size fractions of the applied basalt, as determined by dry sieving.

Size fraction	% of particles
>2 mm	27.63
500 $\mu\text{m}$ – 2 mm	42.19
355 – 500 $\mu\text{m}$	5.48
63- 355 $\mu\text{m}$	16.76
< 63 $\mu\text{m}$	6.94



**Fig. S12:** Temporal evolution of SCE for (A) clover and (B) mustard plots.  $p(B)$ ,  $p(Bi)$  and  $p(BxBi)$  are  $p$  values from the basalt, biochar and basalt x biochar interaction effect respectively. A (+/-) sign before the  $p$  value indicates a positive/negative effect on SCE. N.S. = No significant interaction effect. An inset was added to each panel, containing the mean SCE +/- the standard error of the mean for all measurements taken between 20/12/2023-12/11/2024 for clover plots and 21/11/2023-12/11/2024 for mustard plots.