

Supplementary materials

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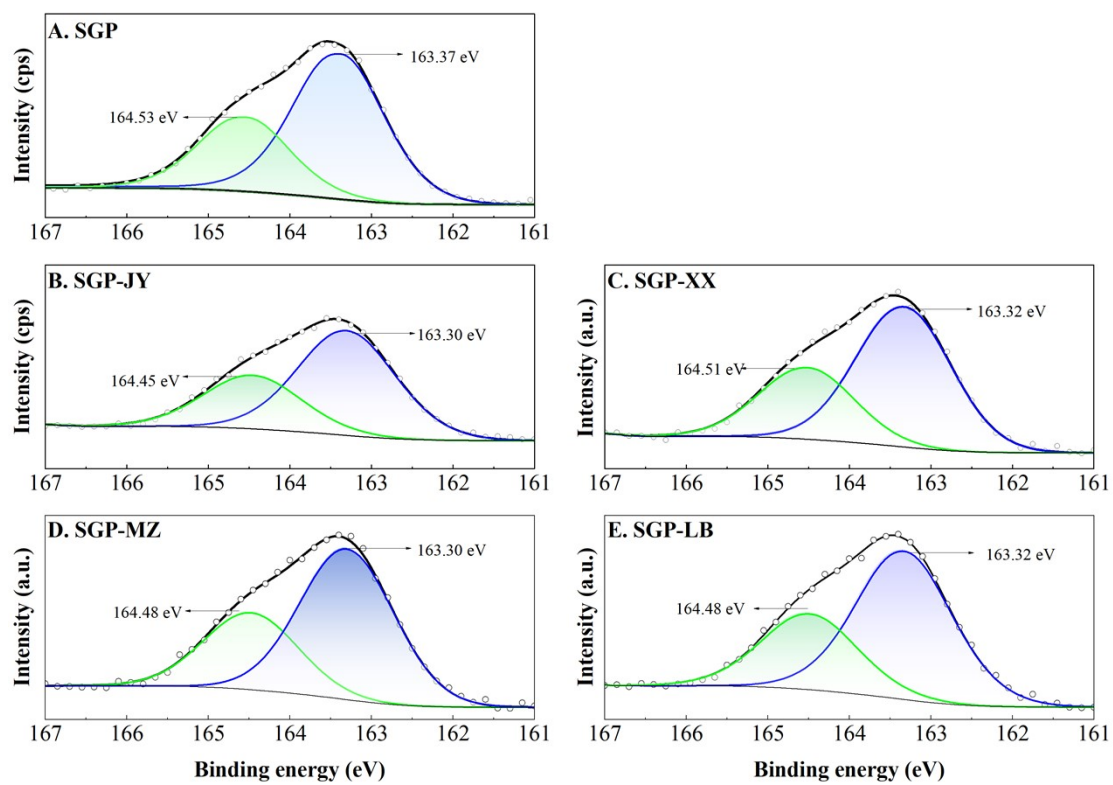


Fig. S1 S2p spectra of SGP variants after 30-day soil incubation

*(A-E: SGP; SGP-JY; SGP-XX; SGP-MZ; SGP-LB)

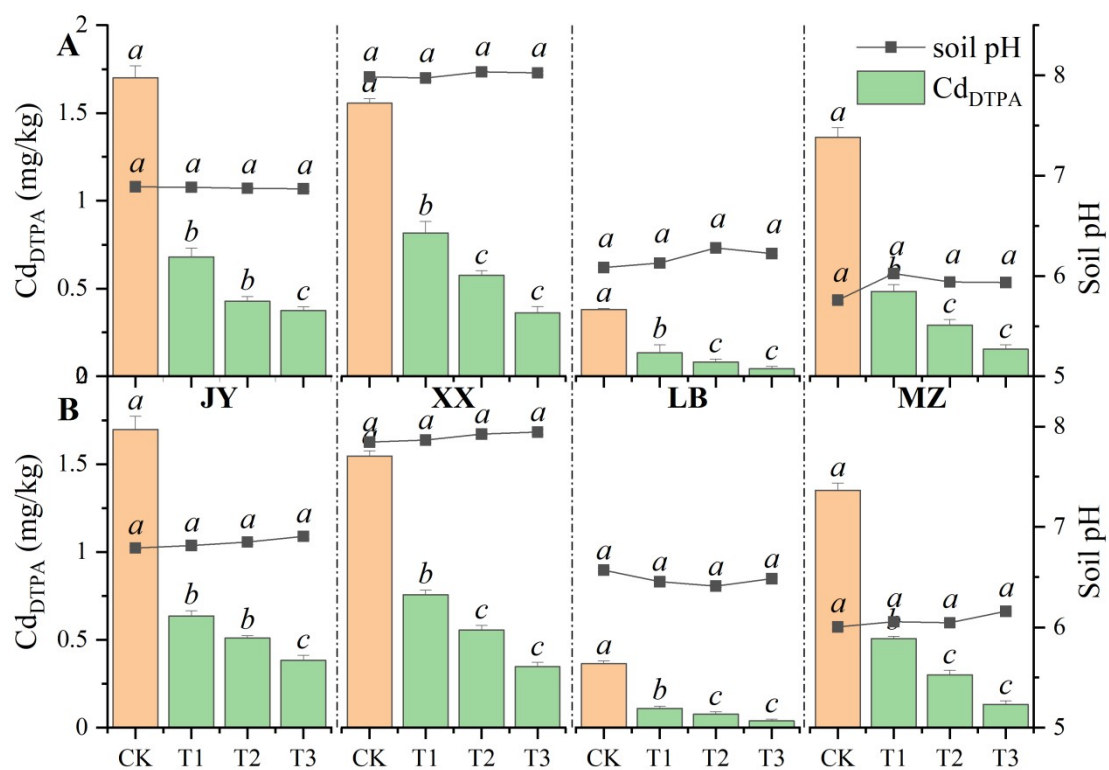


Fig. S2 Soil pH and available Cd contents after simulated rain leaching *(A/B: Acid rain vs natural rain leaching)

The different lowercase letters above the data column and point indicate statistical differences between different treatments.

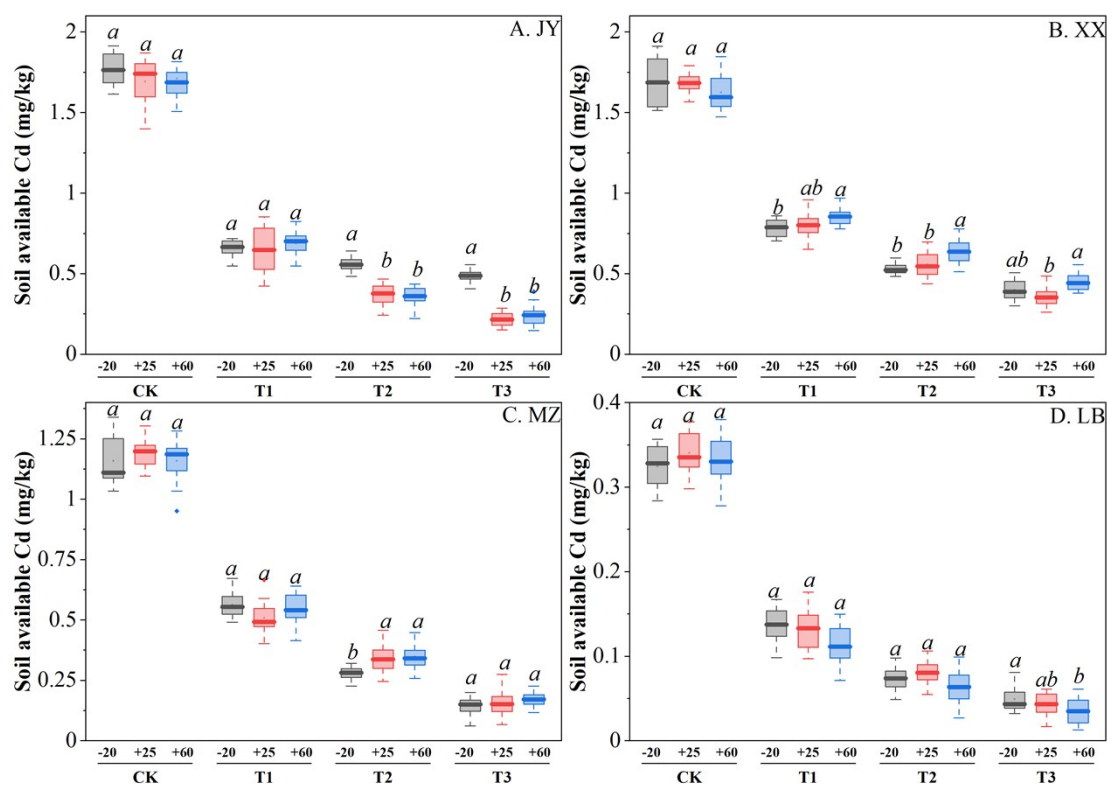


Fig. S3 Soil Cd availability impacted by SGP under different temperature pretreatments in pot experiments *(A-D: Jiyuan, Xinxiang, Mianzhu, Libo soils)

The different lowercase letters above the data column indicate statistical differences between different temperatures for the same treatment.

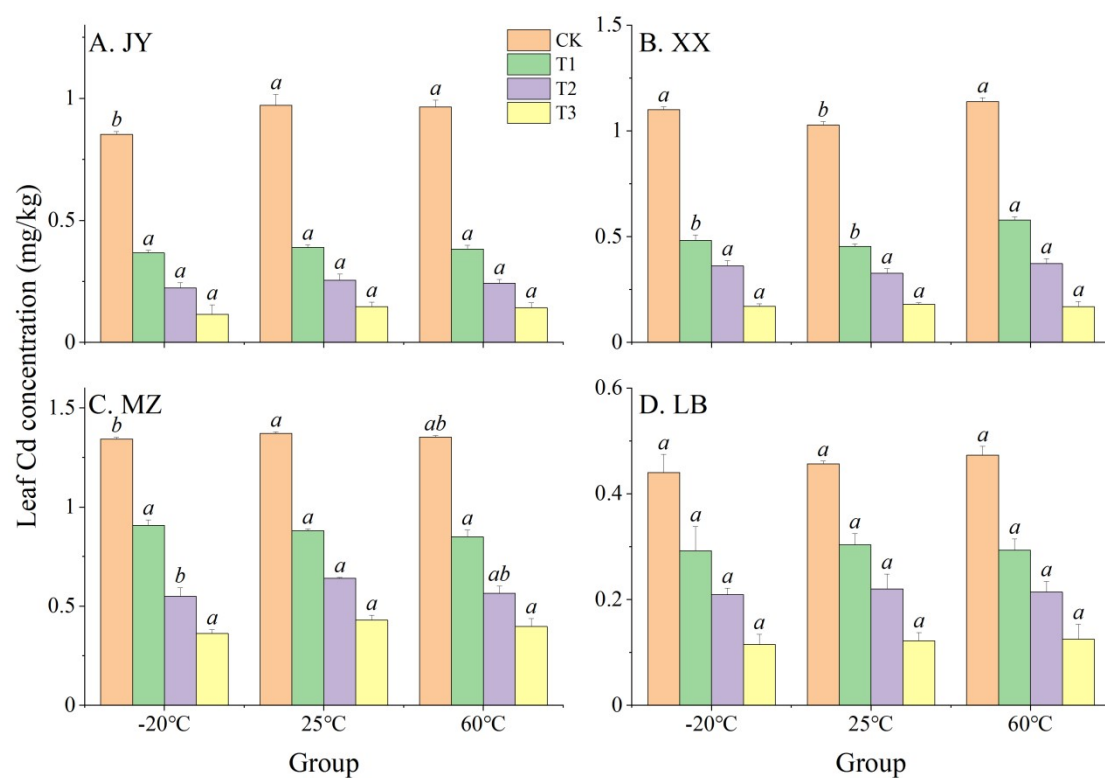


Fig. S4 Pakchoi Cd uptake in SGP amended soils under thermal regimes *(A-D: Jiyuan, Xinxiang, Mianzhu, Libo soils).

The different lowercase letters above the data column indicate statistical differences between different temperatures for the same immobilization treatment.

Table S1 Free sulfhydryl contents and Cd²⁺ sorption amounts of SGP under varying environmental stress conditions

No	Environ mental stress	Free sulfhydryl content (mmol/g)				Sorption amount for Cd ²⁺ (mg/g)			
		Mean	SD	RSD (%)		Mean	SD	RSD (%)	
1	Air	2.22	0.05	2.24	<i>c</i>	24.57	0.71	2.87	<i>a</i>
2	H ₂ O	2.34	0.07	2.95	<i>b</i>	23.25	0.62	2.65	<i>bcd</i>
3	CuSO ₄	2.33	0.07	3.15	<i>b</i>	23.19	0.78	3.36	<i>bcd</i>
4	H ₂ O ₂	2.41	0.07	2.94	<i>a</i>	24.20	0.86	3.57	<i>ab</i>
5	JY soil	2.35	0.06	2.67	<i>b</i>	23.16	1.06	4.58	<i>cd</i>
6	XX soil	2.33	0.06	2.67	<i>b</i>	22.60	1.28	5.69	<i>d</i>
7	MZ soil	2.35	0.08	3.29	<i>b</i>	23.94	0.96	4.02	<i>abc</i>
8	LB soil	2.31	0.07	2.88	<i>b</i>	23.85	0.76	3.17	<i>abc</i>

Table S2 Surface elemental composition and chemical state analysis of SGP samples after soil incubation: XPS peak integration results

Element	Parameter	SGP	SGP-JY	SGP-XX	SGP-LB	SGP-MZ
C1s	Peak BE	284.82	284.82	284.80	284.80	284.78
	At. %	22.505	23.376	23.557	22.202	21.604
Cd3d _{5/2}	Peak BE	402.69	402.72	404.15	404.05	402.33
	At. %	0.008	0.006	0.009	0.005	0.005
Fe2p	Peak BE	713.20	713.16	712.99	712.95	713.13
	At. %	0.718	0.718	0.749	0.767	0.744
Mn2p	Peak BE	641.41	642.77	642.58	639.68	642.56
	At. %	0.073	0.181	0.123	0.136	0.159
O1s	Peak BE	532.25	532.25	532.27	532.23	532.22
	At. %	49.849	49.416	49.604	50.754	51.266
S2p	Peak BE	163.51	163.52	163.50	163.47	163.50
	At. %	5.203	4.944	4.856	4.563	4.662
Si2p	Peak BE	102.80	102.78	102.80	102.76	102.77
	At. %	21.617	21.332	21.081	21.545	21.548
Zn2p _{3/2}	Peak BE	1022.70	1020.71	1020.49	1022.28	1021.97
	At. %	0.028	0.028	0.020	0.028	0.012