Supporting Information

of

A meta-analysis of remediation of Cd-contaminated soil: comparison of remediation agents, pot versus field studies, and biochar versus biochar mixed with other materials

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Table

Table S1 The heterogeneity test and publication bias results of the meta-analysis on soil-crop systems using organic remediation agents

Factors	Effect size	CI 95%		*p*Q	*p* val	*p*E	Stability
pH (153)	0.0621	0.046	0.0781	< .0001	< .0001	0.574	
SOM (71)	0.2184	0.1565	0.2804	< .0001	< .0001	0.8794	
TN (4)	0.2551	–0.0365	0.5467	< .0001	0.0865	0.4415	**no significant**
AP (10)	1.1397	0.6485	1.631	< .0001	< .0001	< .0001	
	1.1397	0.6485	1.631	< .0001	< .0001		**robust**
AK (< 3)							
EC (72)	0.3429	0.2483	0.4374	< .0001	< .0001	0.7738	
CEC (15)	0.2724	0.1829	0.3619	< .0001	< .0001	0.1109	
Available Cd (77)	–0.1876	–0.2658	-0.1094	< .0001	< .0001	0.2296	
Exchangable Cd (67)	–0.1274	–0.2613	0.0066	< .0001	0.0624	0.8719	**no significant**
yield/dry biomass (60)	0.1052	0.0723	0.1382	< .0001	< .0001	0.0108	
	0.1529	0.1146	0.1911	< .0001	< .0001		**robust**
root (81)	–0.37	–0.4556	–0.2844	< .0001	< .0001	0.131	
stem (10)	–0.0798	–0.2723	0.1127	< .0001	0.4164	0.173	**no significant**
leaf (30)	–0.433	–0.6259	–0.2401	< .0001	< .0001	0.029	
	–0.433	–0.6259	–0.2401	< .0001	< .0001		**robust**
grain (51)	–0.432	–0.5678	–0.2962	< .0001	< .0001	< .0001	
	–0.2543	–0.4003	–0.1083	< .0001	0.0006		**robust**

*p*Q:Q statistic *p* value

pval:p-value

*p*E:The *p*-value of the Egger test

if *p*Q > 0.001, using fixed effect model

if *p*val > 0.05, suggesting no statistical significant, need a further sub-group analyses / add more articles

if *p*E < 0.05, suggesting a publication bias, need a further trim-and-fill method

if *p*val' (adjusted *p* val) and *p*val under or higher than 0.05 simultaneously, suggesting result is robust

Table S2 The heterogeneity test and publication bias results of the meta-analysis on soil-crop systems using natural remediation agents

Factors	Effect size	CI 95%		*p*Q	*p* value	*p*E	Stability
pH (90)	0.0533	0.0351	0.0715	< .0001	< .0001	0.6699	
SOM (32)	–0.0549	–0.1309	0.021	< .0001	0.1562	0.064	**no significant**
TN (< 3)							
AP (4)	0.2473	0.0027	0.4919	< .0001	0.0475	0.2862	
AK (< 3)							
EC (29)	0.5185	0.3052	0.7319	< .0001	< .0001	0.6119	
CEC (7)	0.0809	–0.0109	0.1728	< .0001	0.0842	< .0001	**no significant**
	0.0809	–0.0109	0.1728	< .0001	0.0842		**robust**
Available Cd (63)	–0.3713	–0.4766	–0.266	< .0001	< .0001	0.0028	
	–0.3713	–0.4766	–0.266	< .0001	< .0001		**robust**
Exchangable Cd (73)	–0.0979	–0.2309	0.035	< .0001	0.1488	0.5497	**no significant**
yield/dry biomass (40)	0.1765	0.0581	0.2949	< .0001	0.0035	0.9708	
root (57)	–0.4832	–0.614	–0.3523	< .0001	< .0001	0.8049	
stem (19)	–1.2097	–1.5659	–0.8535	< .0001	< .0001	0.4777	
leaf (14)	–1.1952	–1.4833	–0.9072	< .0001	< .0001	0.8002	
grain (26)	–1.0235	–1.2572	–0.7898	< .0001	< .0001	0.5328	

Table S3 The heterogeneity test and publication bias results of the meta-analysis on soil-crop systems using synthetic remediation agents

Factors	Effect size	CI 95%		*p*Q	*p* value	*p*E	Stability
pH (9)	0.0186	–0.0157	0.053	< .0001	0.2878	< .0001	**no significant**
	0.0352	0.0045	0.0659	< .0001	0.0247		**unrobust**
SOM (7)	–1.6501	–2.4868	–0.8134	< .0001	0.0001	< .0001	
	–1.6501	–2.4868	–0.8134	< .0001	0.0001		**robust**
TN (< 3)							
AP (5)	–0.1936	–0.2581	–0.129	< .0001	< .0001	0.3633	
AK (5)	–0.6088	–0.7946	–0.4229	0.3259	<.0001	0.5201	
EC (< 3)							
CEC (9)	–0.0037	–0.0305	0.023	< .0001	0.7845	0.0533	**no significant**
Available Cd (17)	–0.4283	–0.542	–0.3147	< .0001	< .0001	0.118	
Exchangable Cd (6)	–1.3645	–2.9775	0.2485	< .0001	0.0973	< .0001	**no significant**
	–1.3645	–2.9775	0.2485	< .0001	0.0973		**robust**
yield/dry biomass (15)	0.0856	0.0104	0.1607	< .0001	0.0256	0.0035	
	0.1057	0.0342	0.1771		0.0037		**robust**
root (< 3)							
stem (< 3)							
leaf (< 3)							
grain (15)	–0.4832	–0.5921	–0.3744	< .0001	< .0001	0.2685	

Table S4 The heterogeneity test and publication bias results of the meta-analysis on soil-crop systems using mixed remediation agents

Factors	Effect size	CI 95%		*p*Q	*p* value	*p*E	Stability
pH (81)	0.1345	0.1093	0.1596	< .0001	< .0001	0.367	
SOM (45)	0.293	0.2237	0.3623	< .0001	< .0001	0.8	
TN (3)	0.1223	–0.0882	0.3327	< .0001	0.2549	0.0078	**no significant**
	0.1223	–0.0882	0.3327	< .0001	0.2549		**robust**
AP (< 3)							
AK (< 3)							
EC (19)	0.3052	0.067	0.5435	< .0001	0.012	0.7388	
CEC (22)	0.3647	0.1852	0.5442	< .0001	< .0001	0.15	
Available Cd (65)	–0.4514	–0.5188	-0.384	< .0001	< .0001	< .0001	
	–0.4514	–0.5188	-0.384	< .0001	< .0001		**robust**
Exchangable Cd (40)	–0.2829	–0.4458	-0.1199	< .0001	0.0007	0.0067	
	–0.2829	–0.4458	-0.1199	< .0001	0.0007		**robust**
yield/dry biomass (9)	0.3232	0.0746	0.5718	< .0001	0.0108	0.5926	
root (30)	–0.6216	–0.7711	-0.4721	< .0001	< .0001	0.241	
stem (13)	–0.8014	–1.0243	-0.5784	< .0001	< .0001	0.726	
leaf (14)	–1.1952	–1.4833	-0.9072	< .0001	< .0001	0.8002	
grain (45)	0.2726	–0.0863	0.6314	< .0001	0.1366	0.6791	**no significant**

Table S5 The heterogeneity test and publication bias results of the meta-analysis on soil-crop systems using biochar remediation agents

Factors	Effect size	CI 95%		*p*Q	*p* val	*p*E	Stability
pH (190)	0.0876	0.0721	0.1031	< .0001	< .0001	0.5856	
SOM (112)	0.2567	0.2092	0.3043	< .0001	< .0001	0.8254	
TN (5)	0.2759	0.0606	0.4912	< .0001	0.012	0.3151	
AP (10)	1.1397	0.6485	1.631	< .0001	< .0001	< .0001	
	1.1397	0.6485	1.631	< .0001	< .0001		**robust**
AK (< 3)							
EC (85)	0.3567	0.263	0.4504	< .0001	< .0001	0.4607	
CEC (30)	0.3864	0.2566	0.5163	< .0001	< .0001	0.8892	
Available Cd (114)	–0.3652	–0.4308	–0.2996	< .0001	< .0001	< .0001	
	–0.3652	–0.4308	–0.2996	< .0001	< .0001		**robust**
Exchangable Cd (69)	–0.2431	–0.3228	–0.1634	< .0001	< .0001	0.2546	
yield/dry biomass (54)	0.1371	0.0993	0.1749	< .0001	< .0001	0.7279	
root (85)	–0.4095	–0.4918	–0.3272	< .0001	< .0001	0.2948	
stem (10)	–0.0798	–0.2723	0.1127	< .0001	0.4164	0.173	**no significant**
leaf (30)	–0.433	–0.6259	–0.2401	< .0001	< .0001	0.029	
	–0.433	–0.6259	–0.2401	< .0001	< .0001		**robust**
grain (71)	–0.5339	–0.6195	–0.4483	< .0001	< .0001	< .0001	
	–0.3764	–0.4709	–0.2818	< .0001			**robust**

Table S6 Heterogeneity experiments of soil-crop system meta-analysis were conducted using organic remediation agents in field and pot experiments

Factors	Experiment type (n)	Effect size	CI 95%		*p* val
pH	**field (31)**	0.066	0.041	0.091	< .0001
	pot (122)	0.0611	0.042	0.0801	< .0001
SOM	**field (23)**	0.2463	0.1518	0.3409	< .0001
	pot (48)	0.2055	0.1261	0.2848	< .0001
TN	**field (< 3)**				
	pot (< 3)				
AP	**field (<3)**				
	pot (8)	1.3579	0.8564	1.8593	< .0001
AK	**field (< 3)**				
	pot (< 3)				
EC	**field (4)**	0.3412	0.2366	0.4458	< .0001
	pot (68)	0.3435	0.243	0.444	< .0001
CEC	**field (6)**	0.3238	0.1613	0.4864	< .0001
	pot (9)	0.2413	0.1344	0.3481	< .0001
Available Cd	**field (25)**	–0.1104	–0.1485	–0.0723	< .0001
	pot (52)	–0.2257	–0.3407	–0.1106	0.0001
Exchangeable Cd	**field (< 3)**				
	pot (65)	–0.1217	–0.2589	0.0155	**0.0821**
yield	**field (40)**	0.1065	0.0682	0.1448	< .0001
	pot (20)	0.0962	0.0285	0.1638	0.0054

root	**field (22)**	–0.3771	–0.4942	–0.2599	< .0001
	pot (59)	–0.3648	–0.4742	–0.2554	< .0001
stem	**field (< 3)**				
	pot (10)	–0.0798	–0.2723	0.1127	**0.4164**
leaf	**field (< 3)**				
	pot (30)	–0.433	–0.6259	–0.2401	< .0001
grain	**field (31)**	–0.5424	–0.6501	–0.4347	< .0001
	pot (20)	–0.2419	–0.5079	0.024	**0.0746**

Table S7 Heterogeneity experiments of soil-crop system meta-analysis were conducted using natural remediation agents in field and pot experiments

Factors	Experiment type (n)	Effect size	CI 95%		*p* val
pH	**field (14)**	0.0417	0.0014	0.082	0.0423
	pot (79)	0.0555	0.0352	0.0758	< .0001
SOM	**field (8)**	–0.0334	-0.1159	0.0492	**0.4281**
	pot (24)	–0.064	-0.1612	0.0332	**0.1969**
TN	**field (< 3)**				
	pot (< 3)				
AP	**field (< 3)**				
	pot (4)	0.2473	0.0027	0.4919	0.0475
AK	**field (< 3)**				
	pot (< 3)				
EC	**field (< 3)**				
	pot (29)	0.5185	0.3052	0.7319	< .0001
CEC	**field (< 3)**				
	pot (7)	0.0809	–0.0109	0.1728	**0.0842**
Available Cd	**field (6)**	–0.2348	–0.5637	0.094	**0.1617**
	pot (57)	–0.3857	–0.4972	–0.2742	< .0001
Exchangeable Cd	**field (17)**	–0.2062	–0.2658	–0.1467	< .0001
	pot (56)	–0.0551	–0.2261	0.1159	**0.5277**
yield	**field (11)**	0.0709	–0.0007	0.1426	**0.0524**
	pot (29)	0.224	0.0649	0.3831	0.0058

root	**field (3)**	–0.2221	–0.3636	–0.0807	0.0021
	pot (54)	–0.4949	–0.6323	–0.3575	< .0001
stem	**field (<3)**				
	pot (17)	–1.3231	–1.6842	–0.9619	< .0001
leaf	**field (<3)**				
	pot (12)	–1.3501	–1.5922	–1.1079	< .0001
grain	**field (13)**	–0.5997	–0.8219	–0.3774	< .0001
	pot (13)	–1.4264	–1.6901	–1.1628	< .0001

Table S8 Heterogeneity experiments of soil-crop system meta-analysis were conducted using synthetic remediation agents in field and pot experiments

Factors	Experiment type (n)	Effect size	CI 95%		*p* val
pH	**field (5)**	–0.005	–0.019	0.009	**0.4846**
	pot (4)	0.0488	–0.015	0.1127	**0.134**
SOM	**field (5)**	-2.311	–2.3824	–2.2397	< .0001
	pot (< 3)				
TN	**field (< 3)**				
	pot (< 3)				
AP	**field (5)**	–0.1936	–0.2581	-0.129	< .0001
	pot (< 3)				
AK	**field (5)**	–0.6045	–0.8138	–0.3952	< .0001
	pot (< 3)				
EC	**field (< 3)**				
	pot (< 3)				
CEC	**field (5)**	–0.0238	–0.061	0.0134	**0.2108**
	pot (4)	0.0212	–0.0059	0.0483	**0.1249**
Available Cd	**field (15)**	–0.4738	–0.5828	–0.3648	< .0001
	pot (< 3)				
Exchangeable Cd	**field (< 3)**				
	pot (6)	–1.3645	–2.9775	0.2485	**0.0973**
yield	**field (15)**	0.0856	0.0104	0.1607	0.0256
	pot (< 3)				

root	**field (< 3)**				
	pot (< 3)				
stem	**field (< 3)**				
	pot (< 3)				
leaf	**field (< 3)**				
	pot (< 3)				
grain	**field (15)**	–0.4832	–0.5921	–0.3744	< .0001
	pot (< 3)				

Table S9 Heterogeneity experiments of soil-crop system meta-analysis were conducted using mixed remediation agents in field and pot experiments

Factors	Experiment type (n)	Effect size	CI 95%		*p* val
pH	**field (3)**	0.004	–0.0287	0.0366	**0.8112**
	pot (78)	0.1397	0.1143	0.165	< .0001
SOM	**field (< 3)**				
	pot (45)	0.293	0.2237	0.3623	< .0001
TN	**field (< 3)**				
	pot (3)	0.1223	–0.0882	0.3327	**0.2549**
AP	**field (< 3)**				
	pot (< 3)				
AK	**field (< 3)**				
	pot (< 3)				
EC	**field (< 3)**				
	pot (19)	0.3052	0.067	0.5435	0.012
CEC	**field (< 3)**				
	pot (22)	0.3647	0.1852	0.5442	< .0001
Available Cd	**field (3)**	–0.0787	–0.0999	–0.0575	< .0001
	pot (62)	–0.4692	–0.5369	–0.4015	< .0001
Exchangeable Cd	**field (12)**	–0.3863	–0.4932	–0.2794	< .0001
	pot (28)	–0.2259	–0.459	0.0072	**0.0575**
yield	**field (< 3)**				
	pot (9)	0.3232	0.0746	0.5718	0.0108

root	**field (7)**	–0.8935	–1.2874	–0.4996	< .0001
	pot (23)	–0.5184	–0.6502	–0.3867	< .0001
stem	**field (6)**	–0.7523	–1.0878	–0.4169	< .0001
	pot (7)	–0.8498	–1.1687	–0.5309	< .0001
leaf	**field (< 3)**				
	pot (12)	–1.3501	–1.5922	–1.1079	< .0001
grain	**field (9)**	–0.5045	–0.7272	–0.2818	< .0001
	pot (36)	0.4694	0.0458	0.893	0.0299

Table S10 Heterogeneity experiment of subgroup analysis of soil-crop system using biochar

Factors	Experiment type (n)	Effect size	CI 95%		*p* val
pH	**field (29)**	0.0692	0.0444	0.094	< .0001
	pot (161)	0.0908	0.0732	0.1084	< .0001
SOM	**field (23)**	0.2463	0.1518	0.3409	< .0001
	pot (89)	0.2592	0.2046	0.3139	< .0001
TN	**field (< 3)**				
	pot (3)	0.3411	0.3235	0.3588	< .0001
AP	**field (< 3)**				
	pot (8)	1.3579	0.8564	1.8593	<.0001
AK	**field (< 3)**				
	pot (< 3)				
EC	**field (4)**	0.3412	0.2366	0.4458	< .0001
	pot (81)	0.3578	0.2591	0.4565	< .0001
CEC	**field (6)**	0.3238	0.1613	0.4864	< .0001
	pot (24)	0.4015	0.2441	0.5589	< .0001
Available Cd	**field (23)**	–0.1192	–0.1533	–0.0851	< .0001
	pot (91)	–0.4272	–0.5047	–0.3496	< .0001
Exchangeable Cd	**field (< 3)**				
	pot (67)	–0.1642	–0.2954	–0.033	0.0142
yield	**field (37)**	0.1211	0.0827	0.1595	< .0001
	pot (17)	0.1888	0.0535	0.324	0.0062

root	**field (21)**	–0.3969	–0.513	–0.2808	< .0001
	pot (64)	–0.411	–0.5136	–0.3084	< .0001
stem	**field (< 3)**				
	pot (10)	–0.0798	–0.2723	0.1127	**0.4164**
leaf	**field (< 3)**				
	pot (30)	–0.433	–0.6259	–0.2401	< .0001
grain	**field (28)**	–0.5263	–0.6427	–0.4099	< .0001
	pot (43)	–0.5343	–0.6507	–0.4178	< .0001

Table S11 Biochar type subgroup analysis in soil-crop systems

Factors	Biochar type (n)	Effect size	CI 95%		*p* val
pH	**single (140)**	0.0683	0.0513	0.0854	< .0001
	mixed (50)	0.1415	0.1114	0.1716	< .0001
SOM	**single (71)**	0.2184	0.1565	0.2804	< .0001
	mixed (41)	0.3235	0.254	0.3929	< .0001
TN	**single (4)**	0.2551	–0.0365	0.5467	**0.0865**
	mixed (< 3)				
AP	**single (10)**	1.1397	0.6485	1.631	< .0001
	mixed (< 3)				
AK	**single (< 3)**				
	mixed (< 3)				
EC	**single (72)**	0.3429	0.2483	0.4374	< .0001
	mixed (13)	0.4222	0.0751	0.7692	0.0171
CEC	**single (15)**	0.2724	0.1829	0.3619	< .0001
	mixed (15)	0.4971	0.2636	0.7306	< .0001
Available Cd	**single (65)**	–0.2271	–0.3153	–0.1389	<.0001
	mixed (49)	–0.5506	–0.6201	–0.4811	<.0001
Exchangeable Cd	**single (61)**	–0.2293	–0.3164	–0.1422	<.0001
	mixed (8)	–0.3817	–0.493	–0.2704	< .0001
yield	**single (49)**	0.1243	0.0951	0.1534	< .0001
	mixed (5)	0.4862	0.0711	0.9013	0.0217

root	**single (76)**	–0.3942	–0.4831	–0.3053	< .0001
	mixed (9)	–0.536	–0.7334	–0.3386	< .0001
stem	**single (10)**	–0.0798	–0.2723	0.1127	0.4164
	mixed (< 3)				
leaf	**single (30)**	–0.433	–0.6259	–0.2401	< .0001
	mixed (< 3)				
grain	**single (43)**	–0.4817	–0.6056	–0.3578	< .0001
	mixed (26)	–0.631	–0.7202	–0.5418	< .0001

Table S12 Biochar feedstock subgroup analysis in soil-crop systems

Factors	Feedstock type (n)	Effect size	CI 95%		*p* val
pH	**straw (64)**	0.1367	0.1087	0.1647	< .0001
	manure (9)	0.0194	–0.0237	0.0625	**0.3776**
	wood (30)	0.041	0.0184	0.0637	0.0004
	rice hull (7)	0.0255	0.003	0.0479	0.0266
	bamboo (7)	0.0263	–0.0038	0.0563	**0.0865**
	sludge (7)	0.1956	0.0807	0.3105	0.0008
	other (28)	0.0853	0.0378	0.1328	0.0004
SOM	**straw (58)**	0.2357	0.1911	0.2803	< .0001
	wood (10)	0.3908	0.1511	0.6305	0.0014
	other (12)	0.4128	0.3379	0.4877	< .0001
TN					
AP	**manure (8)**	1.3579	0.8564	1.8593	<.0001
AK					
EC	**straw (26)**	0.3233	0.1783	0.4682	< .0001
	manure (8)	1.0436	0.8176	1.2696	< .0001
	wood (17)	0.137	0.063	0.211	0.0003
	bamboo (5)	0.1433	–0.1516	0.4381	0.341
	other (14)	0.2531	0.1586	0.3476	< .0001
CEC	**straw (13)**	0.2201	0.1175	0.3228	< .0001
	other (5)	0.3316	0.2371	0.4261	< .0001
Available Cd	**straw (40)**	–0.4438	–0.5376	–0.35	< .0001

	manure (11)	–0.3127	–0.4316	–0.1938	< .0001
	wood (18)	–0.0201	–0.11	0.0699	**0.662**
	rice hull (3)	–0.8805	–1.6781	–0.083	0.0305
	other (11)	–0.3186	–0.444	–0.1931	< .0001
Exchangeable Cd	straw (30)	–0.1698	–0.2315	–0.1081	< .0001
	wood (7)	–0.0163	–0.054	0.0215	**0.3987**
	bamboo (18)	–0.5345	–0.7557	–0.3133	< .0001
	other (5)	–0.0733	–0.0953	–0.0513	< .0001
yield	straw (25)	0.1083	0.0693	0.1473	< .0001
	wood (3)	0.1109	0.073	0.1488	< .0001
	sludge (6)	0.1606	0.1146	0.2066	< .0001
	other (5)	0.2239	0.0833	0.3645	0.0018
root	straw (14)	–0.5906	–0.7139	–0.4674	< .0001
	manure (9)	–0.7795	–1.22	–0.339	0.0005
	wood (14)	–0.1137	–0.2034	–0.024	0.013
	bamboo (13)	–0.4117	–0.5567	–0.2667	< .0001
	other (20)	–0.3184	–0.4532	–0.1836	< .0001
stem	other (7)	–0.0448	–0.2391	0.1495	**0.6512**
leaf	wood (4)	–0.098	–0.2747	0.0786	**0.2766**
	sludge (6)	–0.4548	–0.8079	–0.1017	0.0116
	other (13)	–0.1929	–0.2732	–0.1125	< .0001
grain	straw (47)	–0.5668	–0.634	–0.4997	< .0001
	wood (7)	–0.717	–0.9647	–0.4694	< .0001

	other (3)	–0.2591	–0.4428	–0.0754	0.0057

Table S13 Biochar pH subgroup analysis in soil-crop systems

Factors	Biochar pH range (n)	Effect size	CI 95%		*p* val
pH	**< 8 (16)**	0.0222	–0.0335	0.078	**0.4347**
	8–10 (56)	0.0645	0.0416	0.0874	< .0001
	> 10 (69)	0.1268	0.1015	0.1522	< .0001
SOM	**< 8 (4)**	0.0687	–0.0116	0.149	**0.0934**
	8–10 (25)	0.3024	0.1911	0.4136	< .0001
	> 10 (56)	0.2178	0.1577	0.2779	< .0001
TN					
AP	**< 8 (< 3)**				
	8–10 (< 3)				
	> 10 (8)	1.3579	0.8564	1.8593	< .0001
AK					
EC	**< 8 (3)**	0.2041	0.0902	0.318	0.0004
	8–10 (29)	0.3278	0.1987	0.457	< .0001
	> 10 (21)	0.5818	0.3639	0.7998	< .0001
CEC	**< 8 (< 3)**				
	8–10 (8)	0.2381	0.0786	0.3975	0.0034
	> 10 (3)	0.3876	0.2574	0.5179	< .0001
Available Cd	**< 8 (7)**	–0.6416	–1.2463	–0.0369	0.0376
	8–10 (23)	–0.1556	–0.2706	–0.0407	0.008
	> 10 (52)	–0.3889	–0.4612	–0.3166	< .0001

Exchangeable Cd	**< 8 (9)**	–0.0715	–0.1516	0.0087	**0.0806**
	8–10 (6)	–0.0005	–0.0197	0.0186	**0.9565**
	> 10 (10)	–0.1226	–0.16	–0.0853	< .0001
yield	**< 8 (6)**	0.1208	0.0922	0.1493	< .0001
	8–10 (7)	0.1998	0.1554	0.2441	< .0001
	> 10 (34)	0.1163	0.0762	0.1564	< .0001
root	**< 8 (< 3)**				
	8–10 (26)	–0.3872	–0.5122	–0.2623	< .0001
	>10 (24)	–0.5626	–0.7655	–0.3598	< .0001
stem	**< 8 (< 3)**				
	8–10 (7)	0.0781	–0.0262	0.1824	**0.142**
	> 10 (< 3)				
leaf	**< 8 (6)**	–0.1752	–0.2826	–0.0678	0.0014
	8–10 (16)	–0.3882	–0.5794	–0.197	< .0001
	> 10 (6)	–0.8186	–1.5129	–0.1243	0.0208
grain	**< 8 (3)**	0.4693	0.3451	0.5936	< .0001
	8–10 (6)	–0.7706	–1.0918	–0.4495	< .0001
	> 10 (47)	–0.5447	–0.6123	–0.4772	< .0001

Table S14 Biochar temperature subgroup analysis in soil-crop systems

Factors	Temperature (℃, n)	Effect size	CI 95%		*p* val
pH	**300–400 (20)**	0.0304	–0.0295	0.0903	**0.9952**
	401–500 (55)	0.132	0.1005	0.1636	< .0001
	501–600 (19)	0.0818	0.0467	0.1169	< .0001
	> 600 (8)	0.0179	–0.0308	0.0666	**0.4712**
SOM	**300–400 (15)**	0.344	0.2165	0.4715	< .0001
	401–500 (44)	0.2642	0.2194	0.3089	< .0001
	501–600 (4)	0.3055	–0.2029	0.8139	**0.2388**
TN					
AP	**> 600 (8)**	1.3579	0.8564	1.8593	< .0001
AK					
EC	**300–400 (15)**	0.1759	0.1085	0.2434	< .0001
	401–500 (10)	0.5327	0.2363	0.8291	0.0004
	501–600 (6)	0.396	0.2554	0.5366	< .0001
	> 600 (10)	0.8898	0.6155	1.164	< .0001
CEC	**401–500 (5)**	0.2294	0.0271	0.4316	0.0262
	501-600 (3)	0.2573	0.2152	0.2995	< .0001
	> 600 (< 3)				
Available Cd	**300–400 (8)**	–0.2867	–0.4322	–0.1412	0.0001
	401–500 (44)	–0.3574	–0.437	–0.2777	< .0001
	501–600 (7)	0.1344	0.0242	0.2446	0.0168
	> 600 (8)	–0.3649	–0.4997	–0.2301	< .0001

Exchangeable Cd	**300–400 (8)**	–0.0502	–0.0821	–0.0184	0.002
	401–500 (11)	–0.0544	–0.0731	–0.0358	< .0001
	501–600 (23)	–0.4512	–0.6413	–0.2611	< .0001
	> 600 (< 3)				
yield	**401–500 (34)**	0.1163	0.0762	0.1564	< .0001
root	**300–400 (10)**	–0.2843	–0.3856	–0.183	< .0001
	401–500 (24)	–0.3932	–0.548	–0.2384	< .0001
	501–600 (14)	–0.4029	–0.5348	–0.2711	< .0001
	> 600 (8)	–0.8503	–1.3241	–0.3765	0.0004
stem	**401–500 (4)**	–0.4317	–0.9332	0.0698	**0.0916**
leaf	**300–400 (6)**	–0.3051	–0.4074	–0.2028	< .0001
	401–500 (4)	–0.7616	–1.8128	0.2896	**0.1556**
grain	**300–400 (12)**	–0.6465	–0.8182	–0.4747	< .0001
	401–500 (51)	–0.4924	–0.5915	–0.3934	< .0001
	501–600 (3)	–0.1763	–0.2607	–0.0918	< .0001

Table S15 Biochar dosage subgroup analysis in soil-crop systems

Factors	dosage (n)	Effect size	CI 95%		*p* val
pH	**< 20 (18)**	0.0674	0.0352	0.0996	< .0001
	20–40 (10)	0.071	0.0258	0.1162	0.0021
	< 1.0% (72)	0.0561	0.0354	0.0768	< .0001
	1.0%–3.0% (58)	0.1194	0.0839	0.1549	< .0001
	> 3.0% (31)	0.1189	0.086	0.1518	< .0001
SOM	**< 20 (16)**	0.1626	0.0563	0.2689	0.0027
	20–40 (6)	0.4309	0.3601	0.5017	< .0001
	< 1.0% (43)	0.2396	0.1691	0.3101	< .0001
	1.0%–3.0% (37)	0.2568	0.1762	0.3373	< .0001
	> 3.0% (9)	0.3569	0.0879	0.626	0.0093
TN	**1.0%–3.0% (3)**	0.3411	0.3235	0.3588	< .0001
AP	**1.0%–3.0% (4)**	1.9734	1.6832	2.2636	< .0001
EC	**< 20 (4)**	0.3412	0.2366	0.4458	< .0001
	< 1.0% (39)	0.2962	0.1598	0.4327	< .0001
	1.0%–3.0% (32)	0.3281	0.1775	0.4786	< .0001
	> 3.0% (10)	0.7425	0.4293	1.0557	< .0001
CEC	**< 20 (6)**	0.3238	0.1613	0.4864	< .0001
	< 1.0% (13)	0.5835	0.3356	0.8314	< .0001
	1.0%–3.0% (6)	0.2217	0.1341	0.3094	< .0001
	> 3.0% (5)	0.1466	0.043	0.2502	0.0056

Available Cd	**< 20 (14)**	–0.1184	–0.1661	–0.0707	< .0001
	20–40 (9)	–0.1214	–0.1739	–0.069	< .0001
	1.0%-3.0% (38)	–0.4427	–0.5795	–0.3059	< .0001
	> 3.0% (7)	–0.7463	–0.9913	–0.5013	< .0001
Exchangeable Cd	**< 1.0% (15)**	–0.2643	–0.391	–0.1376	< .0001
	1.0%–3.0% (44)	–0.2253	–0.3396	–0.111	0.0001
	> 3.0% (8)	–0.2741	–0.4395	–0.1086	0.0012
yield	**< 20 (24)**	0.1038	0.0488	0.1587	0.0002
	20–40 (13)	0.146	0.1001	0.192	< .0001
	< 1.0% (9)	0.2775	0.0173	0.5378	0.0366
	1.0%–3.0% (4)	0.1331	0.0914	0.1748	< .0001
	> 3.0% (3)	0.1774	0.1205	0.2343	< .0001
root	**< 20 (16)**	–0.3584	–0.4887	–0.2281	< .0001
	20–40 (5)	–0.5307	–0.7769	–0.2844	< .0001
	< 1.0% (35)	–0.3351	–0.4373	–0.233	< .0001
	1.0%–3.0% (25)	–0.4611	–0.6594	–0.2628	< .0001
	> 3.0% (4)	–0.8669	–1.4325	–0.3012	0.0027
stem	**< 1.0% (6)**	–0.0327	–0.2328	0.1675	0.7491
	> 3.0% (4)	–0.4317	–0.9332	0.0698	0.0916
leaf	**< 1.0% (17)**	–0.1769	–0.2418	–0.1119	< .0001
	1.0%–3.0% (4)	–0.4654	–0.7698	–0.161	0.0027
	> 3.0% (9)	–0.9342	–1.5166	–0.3517	0.0017
grain	**< 20 (18)**	–0.5188	–0.7077	–0.3299	< .0001

20–40 (10)	–0.5571	–0.6798	–0.4344	< .0001
< 1.0% (11)	–0.5001	–0.6304	–0.3698	< .0001
1.0%–3.0% (24)	–0.5705	–0.7012	–0.4398	< .0001
> 3.0% (8)	–0.4867	–0.9594	–0.014	0.0436