

# **A sustainable approach towards the restoration of lead-contaminated soils through nutrient-doped olive waste-derived biochar application**

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**Table S1.** Average pH value of soil samples as affected by applied biochars

	CK		Pb1		Pb2		Pb1		Pb2		Pb1		Pb2	
Time(days)	CK-Pb1	CK-Pb2	BC1	BC2	BC1	BC2	BC-Si1	BC-Si2	BC-Si1	BC-Si2	BC-Si-NP1	BC-Si-NP2	BC-Si-NP1	BC-Si-NP2
1	7.31	7.33	7.4	7.41	7.41	7.46	7.39	7.39	7.35	7.38	7.42	7.42	7.46	7.48
3	7.36	7.38	7.42	7.43	7.43	7.49	7.41	7.41	7.37	7.41	7.44	7.44	7.49	7.51
7	7.40	7.42	7.44	7.46	7.45	7.52	7.43	7.44	7.39	7.45	7.46	7.48	7.51	7.53
15	7.45	7.46	7.47	7.49	7.48	7.54	7.45	7.47	7.41	7.47	7.48	7.51	7.53	7.56
30	7.47	7.59	7.5	7.54	7.52	7.59	7.47	7.5	7.43	7.51	7.54	7.55	7.59	7.60
45	7.48	7.6	7.53	7.59	7.59	7.61	7.49	7.56	7.48	7.52	7.6	7.62	7.61	7.64

CK = control, Pb1 = Pb added at 100 mg kg<sup>-1</sup>, Pb2 = Pb added at 200 mg kg<sup>-1</sup>, BC = biochar, BC1= biochar added at 1% (w/w), BC2 = biochar added at 2% (w/w), BCSi = Silica embeded biochar, BCSiNP = nutrient loaded biochar.

**Table S2.** Effects of applied biochars on available heavy metals in soil.

		<b>CK- Pb1</b>	<b>CK- Pb2</b>	<b>BC1- Pb1</b>	<b>BC2- Pb1</b>	<b>BC1- Pb2</b>	<b>BC2- Pb2</b>	<b>BCSi1- Pb1</b>	<b>BCSi2- Pb1</b>	<b>BCSi1- Pb2</b>	<b>BCSi2- Pb2</b>	<b>BCSiNP1- Pb1</b>	<b>BCSiNP2- Pb1</b>	<b>BCSiNP1- Pb2</b>	<b>BCSiNP2- Pb2</b>
<b>As</b>	<b>D1</b>	-0.184	-0.14	-0.376	-0.046	-0.472	0.096	-0.046	-0.07	-0.206	-0.14	0.198	-0.1	0.286	-1.092
	<b>D3</b>	0.106	0.138	-0.24	-0.712	-0.878	-0.974	-1.046	-0.826	-0.89	-0.846	-0.974	-0.876	-1.088	-0.734
	<b>D7</b>	-0.77	-1.1	-0.95	-0.568	-1.074	-1.108	-0.938	-1.178	-1.296	-1.032	-0.386	-0.61	-0.478	-0.334
	<b>D15</b>	-0.216	-0.152	-0.248	-0.112	0.002	0.17	0.34	0.028	0.102	0.11	0.316	-0.004	-0.15	-0.126
	<b>D30</b>	0.108	0.054	-0.346	0.08	0.046	0.112	-0.756	-0.45	-0.534	-0.49	-0.562	-0.262	-0.36	0.048
	<b>D45</b>	-0.074	0.184	-0.046	0.168	0.12	0.114	-0.05	0.066	0.288	0.062	0.142	0.018	0.218	0.144
<b>Cd</b>	<b>D1</b>	-0.148	-0.144	-0.098	-0.1	-0.068	-0.078	-0.06	-0.056	-0.04	-0.042	-0.064	-0.04	-0.058	0.73
	<b>D3</b>	-0.076	-0.032	-0.024	-0.026	-0.034	-0.008	-0.014	-0.006	0	-0.032	-0.012	0.028	-0.02	0.002
	<b>D7</b>	-0.018	0.032	0.022	-0.014	0.068	0.036	0.05	0.04	0.058	-0.044	-0.054	-0.016	-0.032	-0.052
	<b>D15</b>	-0.086	-0.066	-0.078	-0.07	-0.088	-0.074	-0.118	-0.092	-0.092	-0.096	-0.12	-0.084	-0.056	-0.084
	<b>D30</b>	-0.05	-0.048	-0.048	-0.062	-0.028	-0.044	-0.048	-0.052	0.002	-0.05	-0.016	-0.044	-0.046	-0.082
	<b>D45</b>	-0.066	-0.078	-0.08	-0.11	-0.086	-0.126	-0.068	-0.068	-0.024	-0.044	-0.1	-0.046	-0.02	-0.088
<b>Cr</b>	<b>D1</b>	0.25	0.154	0.01	-0.018	0.048	-0.084	0.082	0.102	0.126	0.136	0.14	0.213	0.058	-0.34
	<b>D3</b>	0.54	0.194	0.046	0.292	0.282	0.214	0.148	0.154	0.164	0.108	0.032	0.036	0.027	0.0106
	<b>D7</b>	0.278	-0.066	0.46	0.204	-0.072	0.206	0.226	0.354	0.248	0.256	0.338	0.364	0.39	0.362
	<b>D15</b>	0.364	0.444	0.464	0.398	0.35	0.438	0.468	0.362	0.49	0.3	0.396	0.432	0.464	0.392
	<b>D30</b>	0.268	0.268	0.478	0.458	0.408	0.516	0.452	0.408	0.292	0.4	0.328	0.556	0.41	0.426
	<b>D45</b>	0.372	0.366	0.438	0.57	0.382	0.34	0.388	0.652	0.338	0.364	0.398	0.344	0.244	0.496
<b>Cu</b>	<b>D1</b>	1.292	1.264	1.5	1.778	1.484	1.734	1.774	1.842	1.262	1.06	1.494	1.14	1.164	0.42
	<b>D3</b>	1.622	1.408	0.758	1.476	1.202	1.174	1.284	0.978	1.192	1.31	1.156	0.786	1.038	1.198
	<b>D7</b>	1.118	0.81	1.1	1.136	1.474	1.108	1.022	1.154	1.198	1.128	0.364	1.172	1.056	0.812
	<b>D15</b>	1.31	1.23	1.244	1.41	1.324	1.254	1.284	1.312	1.25	1.364	1.076	0.924	1.198	1.258
	<b>D30</b>	1.346	1.206	1.096	1.302	1.054	1.204	0.874	1.354	1.354	1.028	1.302	1.362	1.53	1.11
	<b>D45</b>	1.328	1.266	1.276	1.32	1.368	1.208	1.376	1.34	1.004	1.27	0.77	0.958	0.848	0.618
<b>Fe</b>	<b>D1</b>	66.88	85.52	104.2	166.4	156.46	176.04	150.8	130.42	112.92	88.54	136.36	130.18	100.56	66.66
	<b>D3</b>	132.06	134.8	17.19	56.94	60.08	58.72	53.24	38.44	49.76	53.62	42.32	24.62	36.62	39.74
	<b>D7</b>	58.4	45.74	65.82	67.82	66.78	73.04	57.8	74.98	79.04	57.5	20.7	49.46	39.02	26.52
	<b>D15</b>	60.46	60.4	61.22	68.86	70.46	58.92	48.04	45.78	47.6	44.38	35.3	53.86	57.62	56.84

<b>Mn</b>	<b>D30</b>	98.22	99.82	88.88	110.02	104.22	92.76	48.6	60.46	54.22	40.36	38.68	55.86	65.06	33.94
	<b>D45</b>	60.2	67.02	63.58	53.4	68.06	37	89.1	80.52	62.06	68.36	48.76	63.76	47.78	20.82
	<b>D1</b>	15.196	18.342	22.2	31.46	31.84	31.04	33.24	34.62	27.94	31.22	29.7	35.44	30.22	7.984
	<b>D3</b>	27.8	21	3.682	10.402	12.476	11.676	16.108	9.228	11.736	14.3	8.064	5.296	11.184	11.768
	<b>D7</b>	10.774	9.292	11.8	12.228	14.252	12.006	13.912	16.028	13.136	13.428	4.182	11.666	8.372	5.948
	<b>D15</b>	9.14	10.264	10.372	11.802	12.354	11.532	10.08	10.08	9.94	10.494	7.964	9.576	12.772	13.686
	<b>D30</b>	14.352	15.638	14.252	20.42	17.452	18.566	7.446	10.972	10.164	7.344	7.54	11.4	14.18	8.37
	<b>D45</b>	9.28	10.104	9.786	10.4	12.37	8.14	14.93	12.982	8.634	11.5	7.498	12.572	9.5	5.63
	<b>D1</b>	-0.402	-0.054	0.162	0.846	0.168	1.244	15.968	21.48	11.702	22.12	5.508	20.08	3.66	72.72
	<b>D3</b>	0.096	0.682	-0.112	-1.358	-1.466	-1.396	4.316	4.51	4.934	10.682	-0.29	-0.094	-0.4	2.102
	<b>D7</b>	-1.864	-2.314	-1.772	-1.53	-1.494	-1.308	4.142	8.962	7.486	10.096	-0.512	3.018	0.178	3.228
	<b>D15</b>	-0.398	-0.48	-0.274	-0.274	-0.056	-0.148	4.136	5.578	3.912	1.806	0.896	6.366	2.278	2.02
	<b>D30</b>	-0.068	-0.082	-0.258	-0.066	-0.042	0.072	2.496	9.17	4.272	5.318	0.41	1.772	1.454	1.254
	<b>D45</b>	0.16	0.066	-0.064	-0.138	-0.276	-0.044	6.532	10.846	5.194	8.78	4.05	9.982	1.164	0.544

CK = control, Pb1 = Pb added at 100 mg kg<sup>-1</sup>, Pb2 = Pb added at 200 mg kg<sup>-1</sup>, BC = biochar, BC1= biochar added at 1% (w/w), BC2 = biochar added at 2% (w/w), BCSi = Silica embeded biochar, BCSiNP = nutrient loaded biochar.