

Supplementary material

Evaluation of Compost and Biochar to Mitigate Chlorpyrifos Pollution in Soil and Their Effect on Soil Enzyme Dynamics

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Table S1. Selected physicochemical properties of the soil and amendments used in the study.

Characteristic	Soil	Compost	Biochar
Texture	Sandy clay loam	--	--
Sand (%)	56.4 ± 1.04	--	--
Silt (%)	18.9 ± 0.98	--	--
Clay (%)	24.7 ± 1.01	--	--
pH _{w(1:10)}	7.44 ± 0.10	6.25 ± 0.09	7.89 ± 0.08
EC _{w(1:10)} (dS m ⁻¹)	3.21 ± 0.08	3.10 ± 0.15	4.01 ± 0.08
TSS (mmolc L ⁻¹)	32 ± 0.2	--	--
Total organic carbon (%)	0.87 ± 0.03	35.36 ± 1.32	43.80 ± 1.65
Specific surface area (m ² g ⁻¹)	0.09 ± 0.008	31.37 ± 0.04	94.83 ± 0.09
Pore size (nm)	--	21 ± 0.32	15.0 ± 0.51
Pore volume (cm ³ g ⁻¹)	--	0.0035 ± 0.0001	0.090 ± 0.0001
CEC cmol c kg ⁻¹	5.2 ± 0.87	107.5 ± 4.34	85 ± 3.94

Values are presented as means ± standard error of three replicates, EC: Electrical conductivity, TSS: Total soluble salts, CEC: Cation exchange capacity, The specific surface area of soil and amendments represents the BET surface area calculated from N₂ adsorption isotherms at 77 K. The pore size and pore volume were computed using NOVA Win 2.0 software with N₂ adsorption data.

Table S2. Treatment description and their abbreviations used in the study.

Treatment	Abbreviations
Control	CP ₀ B ₀ C ₀
CP 100 mg kg ⁻¹	CP ₁₀₀
CP100 mg kg ⁻¹ + fresh compost 0.50%	CP ₁₀₀ + FC
CP100 mg kg ⁻¹ + Wheat straw biochar 0.50%	CP ₁₀₀ + WSB

CP 200 mg kg ⁻¹	CP ₂₀₀
CP200 mg kg ⁻¹ + fresh compost 0.50%	CP ₂₀₀ +FC
CP200 mg kg ⁻¹ + Wheat straw biochar 0.50%	CP ₂₀₀ B _{0.25}

Table S3. LSD- Main and Interaction effects (between time interval and treatments) for Chlorpyrifos degradation in non-sterilized and sterilized soil.

Soil Type	Treatment	Time Interval						Mean
		0 day	7 day	15 day	30 day	60 day	120 day	
Non-sterilized/original soil	CP 100	96.28 fgh	74.23 kl	69.00 lm	45.48 nop	23.54 qr	12.13 rs	53.44 E
	CP100 + FC	95.14 f-i	56.34 mn	40.15 op	20.33 qr	5.37 s	1.59 s	36.49 F
	CP100 + WSB	96.09 f-i	80.00 jkl	87.34 hij	56.48 mn	33.02 pq	22.23 qr	62.53 D
	CP200	194.41 a	135.11 c	120.21 de	108.00 ef	83.20 ijk	57.14 mn	116.34 B
	CP200 + FC	193.23 a	122.77 cd	105.08 fg	94.64 g-i	48.07 no	19.90 r	97.28 C
	CP200 + WSB	194.11 a	150.35 b	130.52 cd	119.36 de	93.09 ghi	79.00 jkl	127.74 A
	Mean	144.88 A	103.13 B	92.05 C	74.05 D	47.71 E	32.00 F	
Sterilized soil	CP 100	97.14 jkl	86.04 k-q	81.31 m-q	71.21 qrs	62.71 rs	40.21 t	73.10 F
	CP100 + FC	97.41 jkl	90.14 k-o	86.34 k-q	82.32 l-q	73.07 p-s	59.46 s	81.46 E
	CP100 + WSB	98.04 jk	96.02 j-m	91.37 k-n	87.21 k-p	80.14 n-q	75.43 o-r	88.04 D
	CP200	194.12 ab	180.04 b-e	162.21 fgh	150.73 h	131.34 i	107.48 j	154.32 C
	CP200 + FC	195.44 a	185.00 a-d	168.20 efg	159.77 gh	149.32 h	133.86 i	165.27 B
	CP200 + WSB	196.17 a	191.01 a-c	183.07 a-e	176.15 c-f	169.97 d-g	161.39 fgh	179.63 A
	Mean	146.39 A	138.04 B	128.75 C	121.23 D	111.09 E	96.31 F	

Data are shown as mean of three replicates. Treatments showing the same letters are statistically similar according to LSD test at $p \leq 0.05$. The capital letters show the main effects while, small letters represent interaction effects.

Table S4. Two-way Analysis of Variance Table for Chlorpyrifos degradation in non-sterilized soil.

Source	DF	SS	MS	F	P
Interval	5	148307	29661.4	462.40	0.0000
Treatment	5	121871	24374.2	379.97	0.0000
Interval*Treatment	25	13948	557.9	8.70	0.0000
Error	72	4619	64.1		
Total	107	288744			

Grand Mean 82.304, CV 9.73.

Table S5. Two-way Analysis of Variance Table for Chlorpyrifos degradation in sterilized soil.

Source	DF	SS	MS	F	P
Interval	5	29904	5980.9	67.06	0.0000
Treatment	5	205377	41075.4	460.57	0.0000
Interval*Treatment	25	5456	218.2	2.45	0.0017
Error	72	6421	89.2		
Total	107	247158			

Grand Mean 123.64 CV 7.64.

Table S6. LSD- Main and Interaction effects (between time interval and treatments) for soil enzymes activities.

Soil Enzymes	Treatment	Time Interval						Mean
		0 day	7 days	15 days	30 days	60 days	120 days	
Dehydrogenase	Control	15.530 bc	14.737 bcd	14.710 bcd	13.310 c-f	11.567 ef	14.500 bcd	13.923 B
	CP 100	2.983 n-r	2.807 0-r	2.550 o-r	3.330 m-q	7.540 h-j	11.717 ef	5.624 D
	CP100 + FC	20.077 a	15.013 b-d	12.933 def	13.813 b-e	15.690 b	20.967 a	16.696 A

	CP100 + WSB	11.307 fg	9.030 gh	6.533i-l	7.437 h-k	8.420 hi	9.007 gh	8.541 C
	CP200	1.300 qr	1.203 r	1.023 r	1.983 pqr	3.100 n-r	4.613 l-o	2.404 E
	CP200 + FC	7.753 hij	6.653 i-l	5.110 lmn	9.187 gh	11.290 fg	13.783 b-e	9.425 C
	CP200 + WSB	5.500 j-m	4.500 l-p	3.940 m-p	4.190 m-p	5.200 k-n	6.513 i-l	5.069 D
	Mean	9.207 B	8.906 C	6.686 D	7.607 C	8.972 B	11.586 A	
	Control	20.017 b	19.000 bc	19.497 bc	18.970 bc	17.753 cd	16.723 de	18.592 A
	CP 100	5.090 p-t	4.660 t-x	4.063 stu	5.910 o-s	6.017 o-r	7.007 no	5.617 E
	CP100 + FC	15.607 e	13.090 g	11.937 ghi	13.517 fg	15.237 ef	23.410 a	15.941 B
	CP100 + WSB	7.353 mno	6.863 p-s	6.447 nop	8.023 lmn	9.100 klm	10.410 ijk	8.267 D
	CP200	3.013 uv	2.503 yz	2.007 v	3.440 tuv	3.913 tu	4.240 rstu	3.323 F
Urease	CP200 + FC	9.313 jkl	9.107 k-n	8.913 klm	9.937 jk	11.050 hij	12.680 gh	10.379 C
	CP200 + WSB	6.143 opq	5.220 r-w	4.410 q-u	6.833 nop	7.020 no	7.720 l-o	6.425 E
	Mean	9.505 B	8.635 C	8.182 C	9.519 B	10.013 B	11.741 A	
	Control	7.503 de	7.020 e-h	7.670 de	8.250 cd	8.183 cd	8.920 bc	8.1053 B
	CP 100	3.007 klm	1.343 v-z	0.653 pq	1.950 mno	3.543 jk	4.483 hij	2.7273 D
	CP100 + FC	8.133 cd	6.333 g-i	5.973 fg	8.023 cd	9.837 b	14.013 a	9.1960 A
	CP100 + WSB	4.820 ghi	4.037 m-p	3.670 ijk	5.230 gh	5.943 fg	6.043 fg	5.1413 C
	CP200	1.007 opq	0.503 yz	0.190 q	1.220 n-q	2.183 mno	3.023 klm	1.5247 E
	CP200 + FC	3.420 jkl	2.600 q-u	2.317 lmn	5.013 gh	6.743 ef	7.937 cde	5.0860 C
	CP200 + WSB	1.923 mno	1.807 t-x	1.460 nop	2.940 klm	3.023 klm	5.007 gh	2.8707 D
Phosphatase	Mean	4.2590 C	3.3776 D	3.1333 D	4.6610 C	5.6367 B	7.0610 A	

Data are shown as mean of three replicates. Treatments showing the same letters are statistically similar according to LSD test at $p \leq 0.05$. The capital letters show the main effects while, small letters represent interaction effects.

Table S7. Two way Analysis of Variance Table for Dehydrogenase activity .

Source	DF	SS	MS	F	P
Interval	5	319.72	63.943	31.43	0.0000
Treatment	6	2804.45	467.409	229.73	0.0000
Interval*Treatment	30	317.09	10.570	5.20	0.0000
Error	84	170.91	2.035		
Total	125	3612.17			

Grand Mean 8.6123CV 16.56.

Table S8. Two-way Analysis of Variance Table for Urease activity.

Source	DF	SS	MS	F	P
Interval	5	161.98	32.397	23.23	0.0000
Treatment	6	3401.26	566.876	406.55	0.0000
Interval*Treatment	30	230.65	7.688	5.51	0.0000
Error	84	117.13	1.394		
Total	125	3911.02			

Grand Mean 9.7920 CV 12.30.

Table S9. Two-way Analysis of Variance Table for Phosphatase activity.

Source	DF	SS	MS	F	P
Interval	5	227.84	45.549	85.63	0.0000
Treatment	6	840.40	140.066	263.19	0.0000
Interval*Treatment	30	75.83	2.528	4.75	0.0000
Error	84	44.70	0.532		
Total	125	1188.78			

Grand Mean 4.6881CV 15.56.

Table S10. Completely randomized Analysis of Variance Table for Chlorpyrifos half lives in non-sterilized soil.

Source	DF	SS	MS	F	P
Treatment	5	10116.9	2023.39	45.0	0.0000
Error	12	539.3	44.94		
Total	17	10656.3			

Grand Mean 52.611 CV 12.74.

Table S11. Completely randomized Analysis of Variance Table for Chlorpyrifos half lives in sterilized soil.

Source	DF	SS	MS	F	P
Treatment	5	229643	45928.6	70.7	0.0000
Error	12	7799	649.9		
Total	17	237442			

Grand Mean 228.11 CV 11.18.