

Supplementary Material

Mitigation of Gaseous Emissions from Swine Manure with the Surficial Application of Biochars

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Please note that the full citation of references is provided in the main manuscript. The reference numbers in [] brackets are identical to the list in the main manuscript.

Table S1. Review of research on uses of biochar as a manure additive and tests its effect on gaseous emissions.

Reference	Scale and Duration	Trial #	Treated source	Biochar source	Biochar dose	Biochar pH	Manure pH	Post-trial manure pH	Gaseous emissions reduction (%)					
									NH ₃	H ₂ S	CH ₄	CO ₂	N ₂ O	Indole
Maurer et al. 2017 [22]	Pilot (118 L), 30 d	1	Swine manure	Pine	2.28 kg·m ⁻² 3.11 mm thick	7.28	7.97	7.28	NS	NS	NA	NS	NS	Day 9 – 11.6 Day 30 – 8.7
	Pilot (76.4 L), 30 d	2	Swine manure	Pine	4.56 kg·m ⁻² 6.35 mm thick	7.28	7.97	7.28	Day 6 – 22.6 Day 9 – 15.2 Day 30 – 12.7	NS	Day 10 – (-24.5) Day 30 – (-22)	NS	NS	
	Pilot (84.0 L), 30 d	3	Swine manure	Pine	1) 1.14 kg·m ⁻² 1.58 mm thick 2) 2.28 kg·m ⁻² 3.11 mm thick	7.28	7.97	7.28	NS	1) Day 9 – 30 2) Day 9 – 30 Day 30 - 12	NA	NS	NS	2) Day 30 – 26 2) Day 30 – 26
Note: There is no significant reduction for any other VOCs monitored over three trials: n-butyric acid, valeric acid, isovaleric acid, p-cresol, skatole														
Dougherty et al., 2017 [23]	Pilot (26.5 L), 56 d Volume of manure	1	1) Fresh dairy manure mixed with flush water 2) Fresh scrapped dairy manure	Douglas fir	5 cm thick	9.32			< 1	NS	NA	NA	NA	NA
				Douglas fir	5 cm thick				22	NS	NA	NA	NA	NA

Table S1. (continued).

Reference	Scale and Duration	Trials	Treated source	Biochar source	Biochar dose	Biochar pH	Manure pH	Post-trial manure pH	Gaseous emissions reduction (%)					
									NH ₃	H ₂ S	CH ₄	CO ₂	N ₂ O	Indole
	Pilot (26.5 L), 56 d	1	1) Fresh dairy manure mixed with flush water	Douglas fir bark and wood fiber	5 cm thick	7.28			80	NS	NA	NA	NA	NA
			2) Fresh scrapped dairy manure	Douglas fir bark and wood fiber	5 cm thick				72	NS	NA	NA	NA	NA

Table S2. Review of research on uses of biochar as a soil amendment and its effect on gaseous emissions.

Reference	Scale and Duration	Trials	Treated source	Biochar source	Biochar dose	Biochar pH	Soil pH	Post-trial soil pH	Gaseous emissions reduction (%)					
									NH ₃	H ₂ S	CH ₄	CO ₂	N ₂ O	Indole
Rogovska et al., 2011 [26]	Pilot (0.0011 m ³ PVC column), 500d	1	Surface soil with swine manure	Mixed hardwood and hickory	1) 0 g/kg	7.6	6.4	7.5	NA	NA	NA	1) 0	NS	NA
					2) 5 g/kg	7.6	6.4	7.5	NA	NA	NA	2) -24	NS	NA
					3) 10 g/kg	7.6	6.4	7.5	NA	NA	NA	3) -11	NS	NA
					4) 20 g/kg	7.6	6.4	7.5	NA	NA	NA	4) -8	NS	NA
Troy et al., 2013 [27]	Pilot (0.031 m ³ PVC column), 28 d	1		Swine manure mixed with Sitka spruce sawdust		9.6	6.9	7.24–7.39	NA	NA	NS	-87	NS	NA
				Sitka spruce wood		9.3	6.9	7.11–7.23	NA	NA	NS	-91	NS	NA
Brassard et al., 2018 [25]	Laboratory (747g of soil), 28 d	1	Soil surface	Wood 1 (black spruce and Jack pine)	2%(w/w) of soil	6.8	6.2	5.5	NA	NA	NA	NA	53	NA
				Wood 2 (black spruce and Jack pine)	2%(w/w) of soil	7.6	6.2	5.5	NA	NA	NA	NA	42	NA
				Switchgrass 1	2%(w/w) of soil	6.4	6.2	5.8	NA	NA	NA	NA	90	NA
				Switchgrass 2	2%(w/w) of soil	8.8	6.2	5.7	NA	NA	NA	NA	58	NA
				Pig manure 1	2%(w/w) of soil	8.6	6.2	6.5	NA	NA	NA	NA	-113227	NA
				Pig manure 2	2%(w/w) of soil	9.3	6.2	6.9	NA	NA	NA	NA	-15157	NA

Table S2. (continued).

Reference	Scale and Duration	Trials	Treated source	Biochar source	Biochar dose	Biochar pH	Soil pH	Post-trial soil pH	Gaseous emissions reduction (%)					
									NH ₃	H ₂ S	CH ₄	CO ₂	N ₂ O	Indole
Feng et al., 2011 [24]	Field-scale, Rice growing season	1	Rice field	Cornstalk		9.3-10.12	4.4	NA	NA	NA	91	NA	NA	NA

Table S3. Review of research on uses of biochar as an adsorbent for different gases in laboratory-scale experiments.

Reference	Scale and Duration	Trials	Treated source	Biochar source	Biochar dose	Biochar pH	Treated source pH	Post-trial pH	Gaseous emissions reduction (%)					
									NH ₃	H ₂ S	CH ₄	CO ₂	N ₂ O	Phenol
Komnitsas et al., 2016 [28]	Laboratory scale (100 mL of phenol solution)	1	Phenol solution	Pistachio shells	5 g·L ⁻¹	6.1								76.6
				Pecan shells	5 g·L ⁻¹	5.8	NA	NA	NA	NA	NA	NA	NA	61.7
				Pinewood sawdust	5 g·L ⁻¹	4.6								46.2
Li et al., 2017 [29]	Laboratory scale (250 mL of wastewater) 2 d	1	Swine wastewater	Sugarcane harvest residue + 20% Mg	0.25 g	4 – 10 (adjusted)	7.86	8.49 – 9.92	25.77 (pH=8.5)	NA	NA	NA	NA	NA
Hervy et al., 2017 [30]	Laboratory scale (0.014 m id x 0.0235 m H) 0.14	1	Biogas	Leaf waste HTT* 200°C		9.62		LWB**200 7.91		62.52				
				Leaf waste HTT* 300°C	4.8 x10 ⁻⁴ m ³	9.89	NA	LWB**300 8.34	NA	68.76	NA	NA	NA	NA
				Leaf waste HTT* 400°C		10.23		LWB**400 8.12		84.22				
Shang et al., 2015 [31]	Laboratory scale	1	H ₂ S gas concentration	Camphor HTT 500°C	1 g	9.55				10.9				
				Bamboo HTT 500°C	1 g	10.21	NA	NA	NA	38.2	NA	NA	NA	NA
				Rice-hull HTT 500°C	1 g	10.56				36.6				

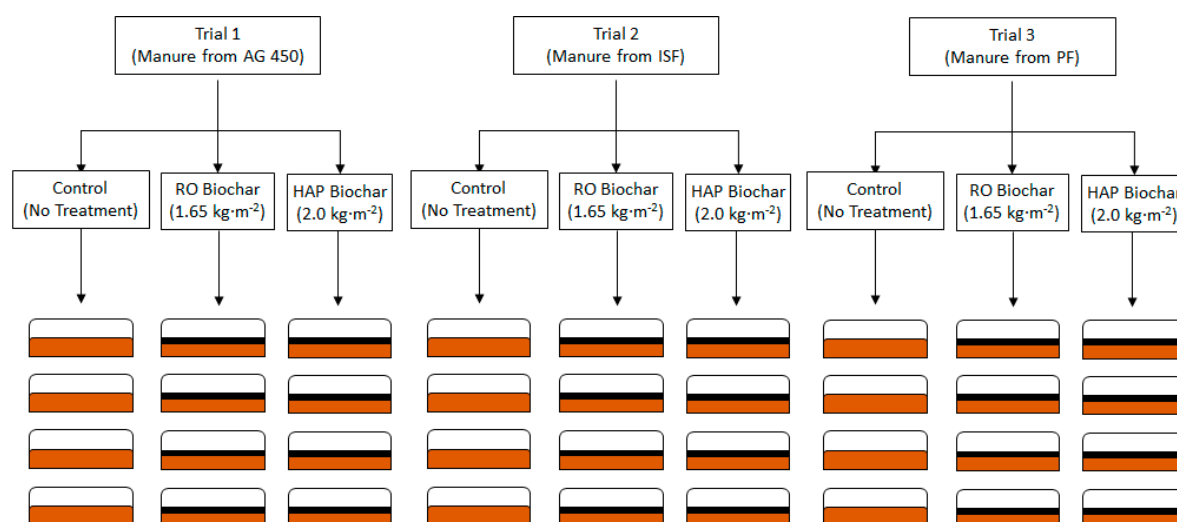


Figure S1. Flow diagram of the experimental setup for the whole research. An example photo of a Trial is illustrated in Figure 1.

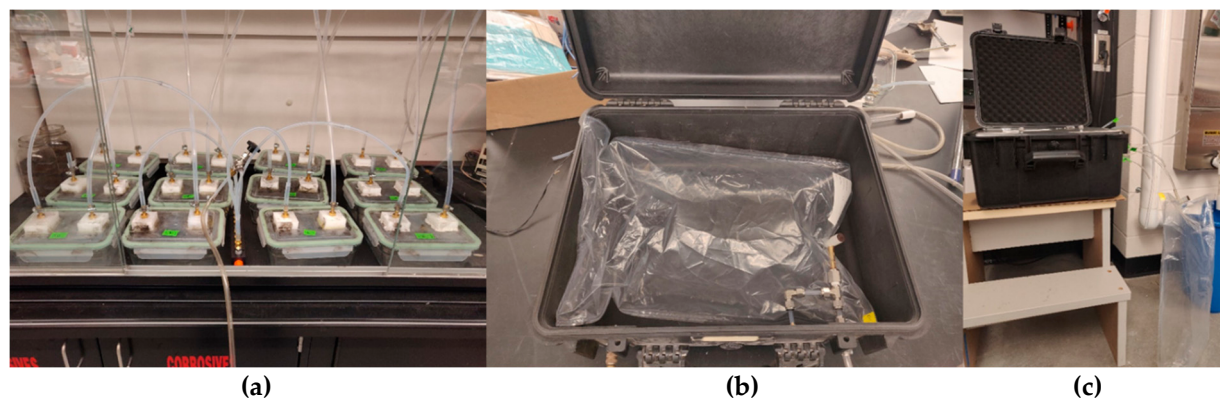


Figure S2. Process of collecting gas samples emitted from manure for analyses of NH_3 and H_2S : (a) The manifold is attached to a block of containers (i.e., replicated treatments of the same kind); (b) Tedlar bag filled with the gas sample in the vacuum chamber; (c) The Tedlar bag is attached to the real-time analyzer.

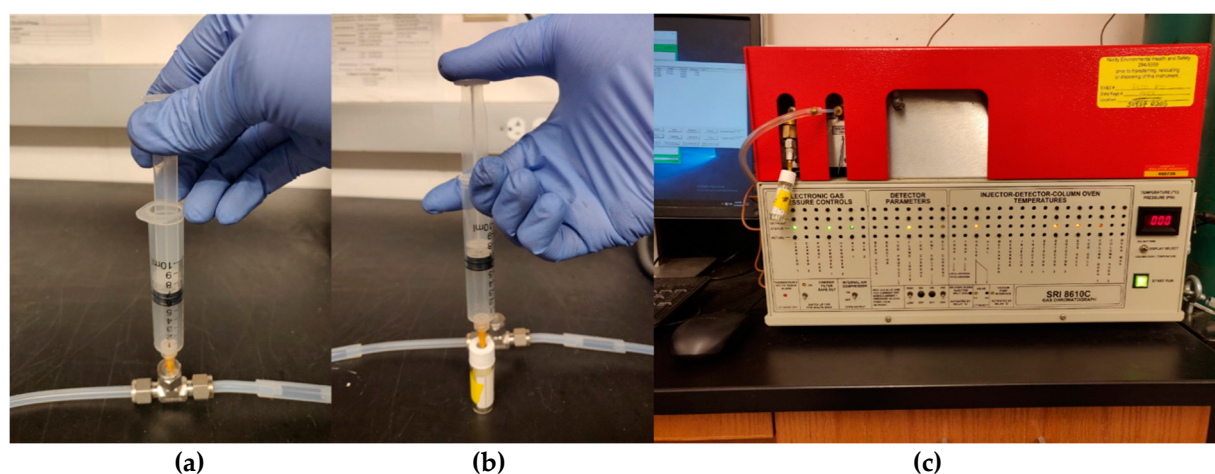


Figure S3. GHG sample collection: (a) extracting gas sample using a syringe; (b) injecting the gas sample in a vial; (c) measuring GHG concentration with a gas chromatograph.

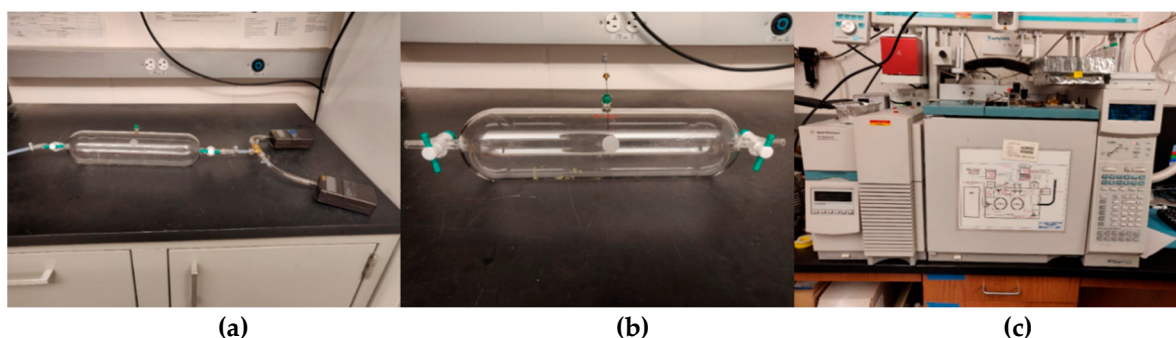


Figure S4. VOC sample collection process: (a) Flushing the glass bulb with sample air for 15 min; (b) SPME is injected in the bulb through septa to collect VOCs; (c) SPME is desorbed into a GC-MS for separation and identification of target odorous VOCs.

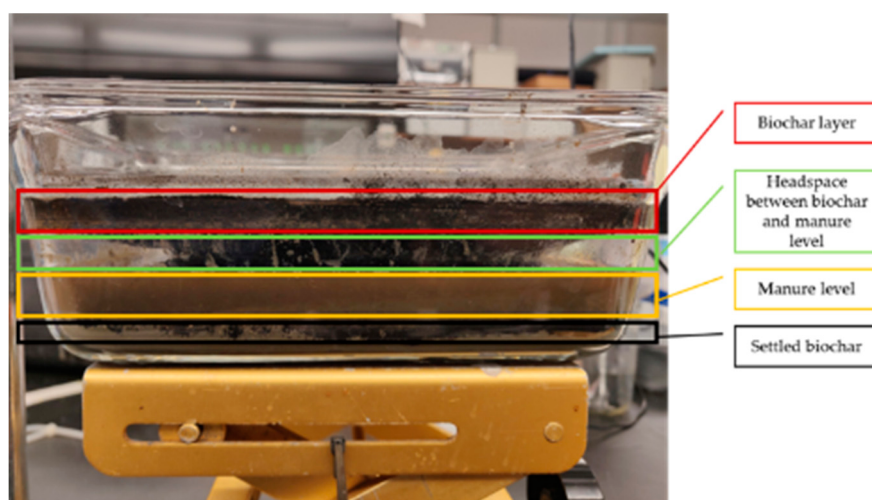


Figure S5. HAP biochar crusted, and headspace between biochar and manure surface was created.

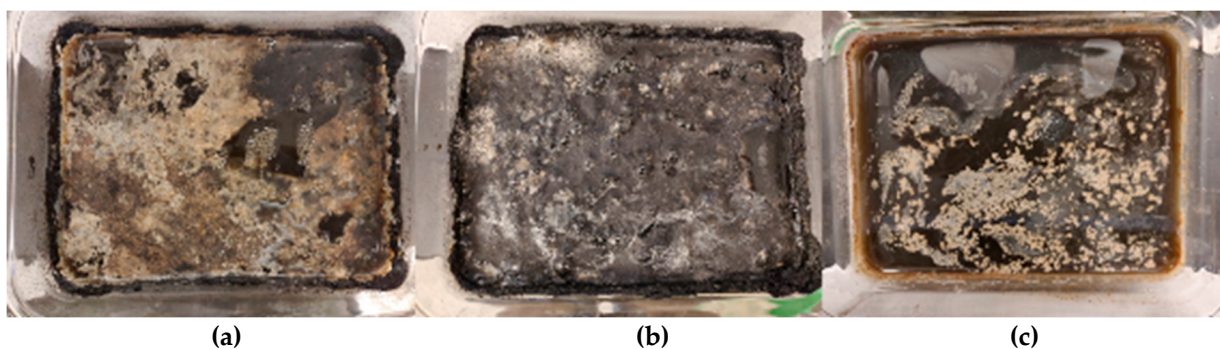


Figure S6. Overview photos of each treatment after the end of the trial 3: (a) HAP biochar completely sank and the manure surface crusted; (b) half of applied RO biochar became wet and floated on the manure surface; (c) some crust was observed on the surface of control manure.

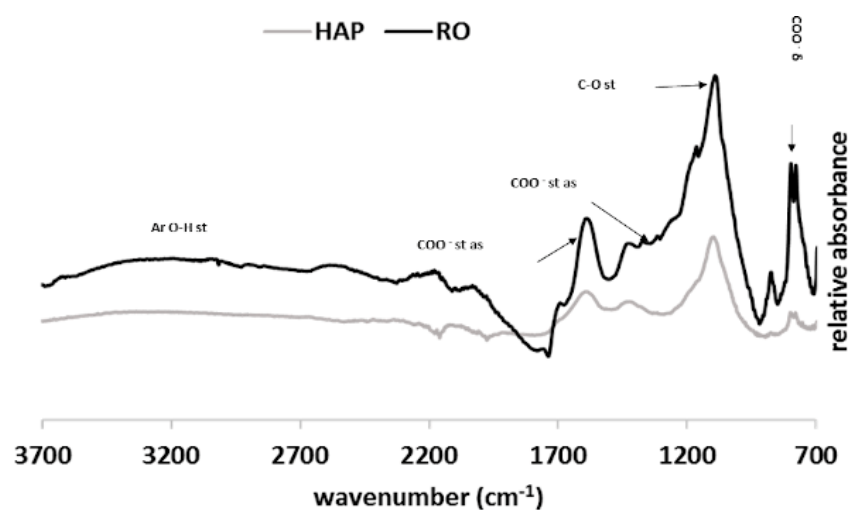
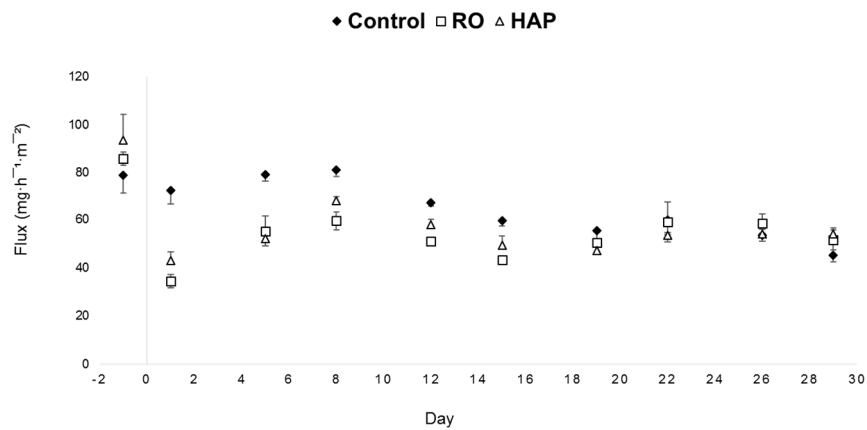
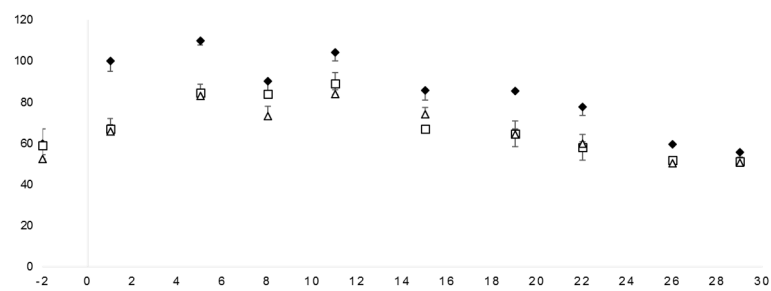


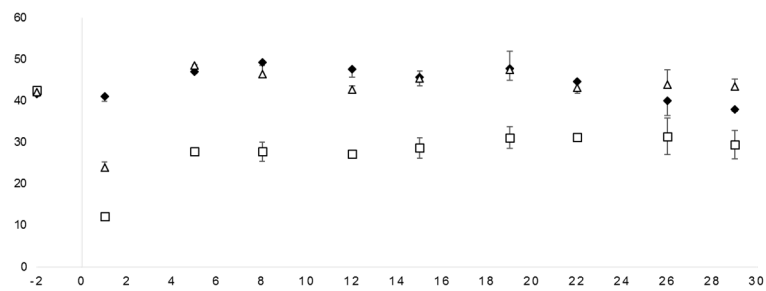
Figure S7. Results of FTIR analyses can explain the hydrophobicity and floating behavior when biochars are surficially applied to manure.



(a)



(b)



(c)

Figure S8. Biochar effect on NH_3 emissions from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. ‘-2 day’ data signifies the pre-trial and measurement of emissions before biochar treatment. Note; emitting surface for flux estimation was assumed to be equal to 19 cm $\times$ 14.5 cm.

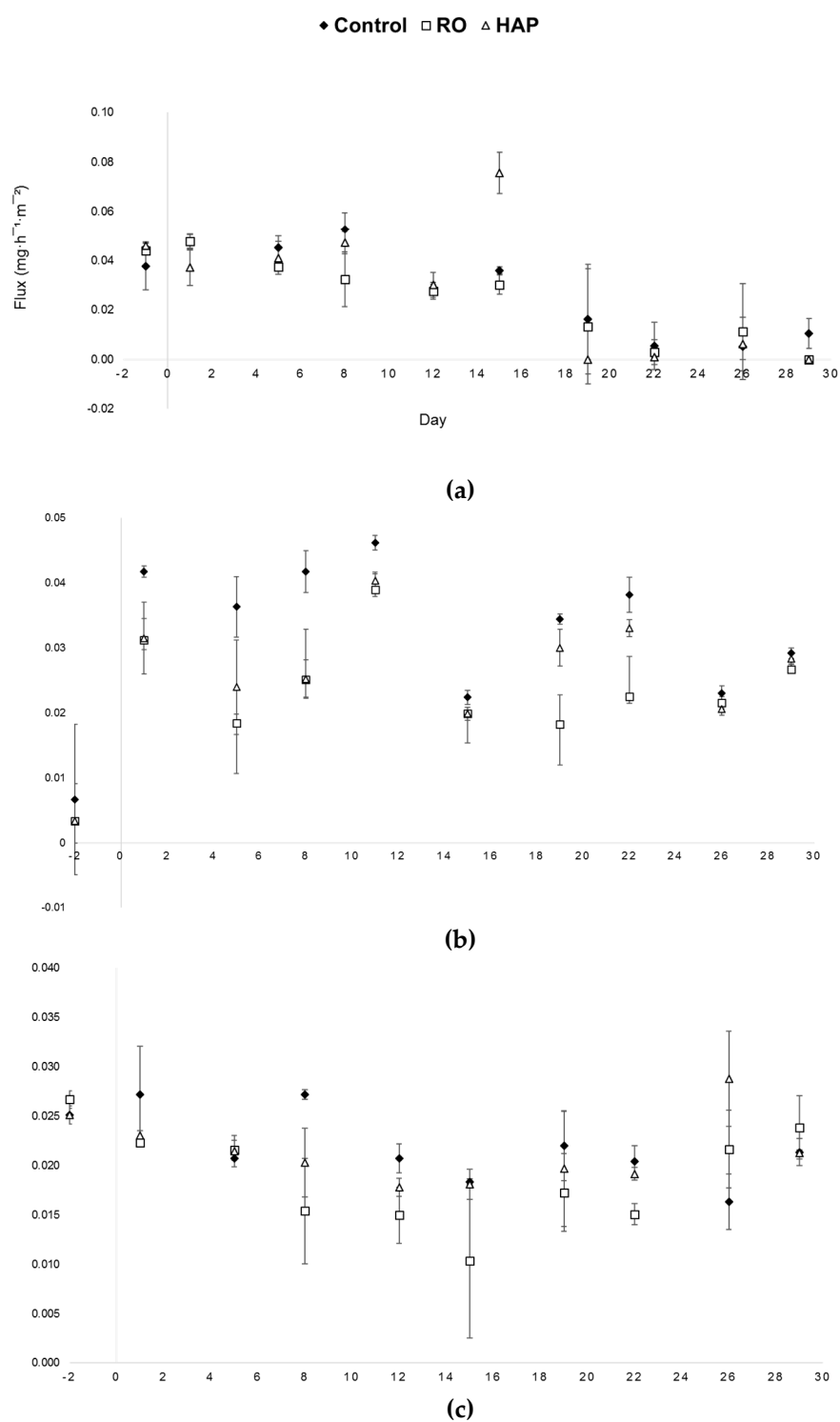


Figure S9. Biochar effect on H_2S emission from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. ‘-2 day’ data signifies the pre-trial and measurement of emissions before biochar treatment. Note: emitting surface for flux estimation was assumed to be equal to $19\text{ cm} \times 14.5\text{ cm}$.

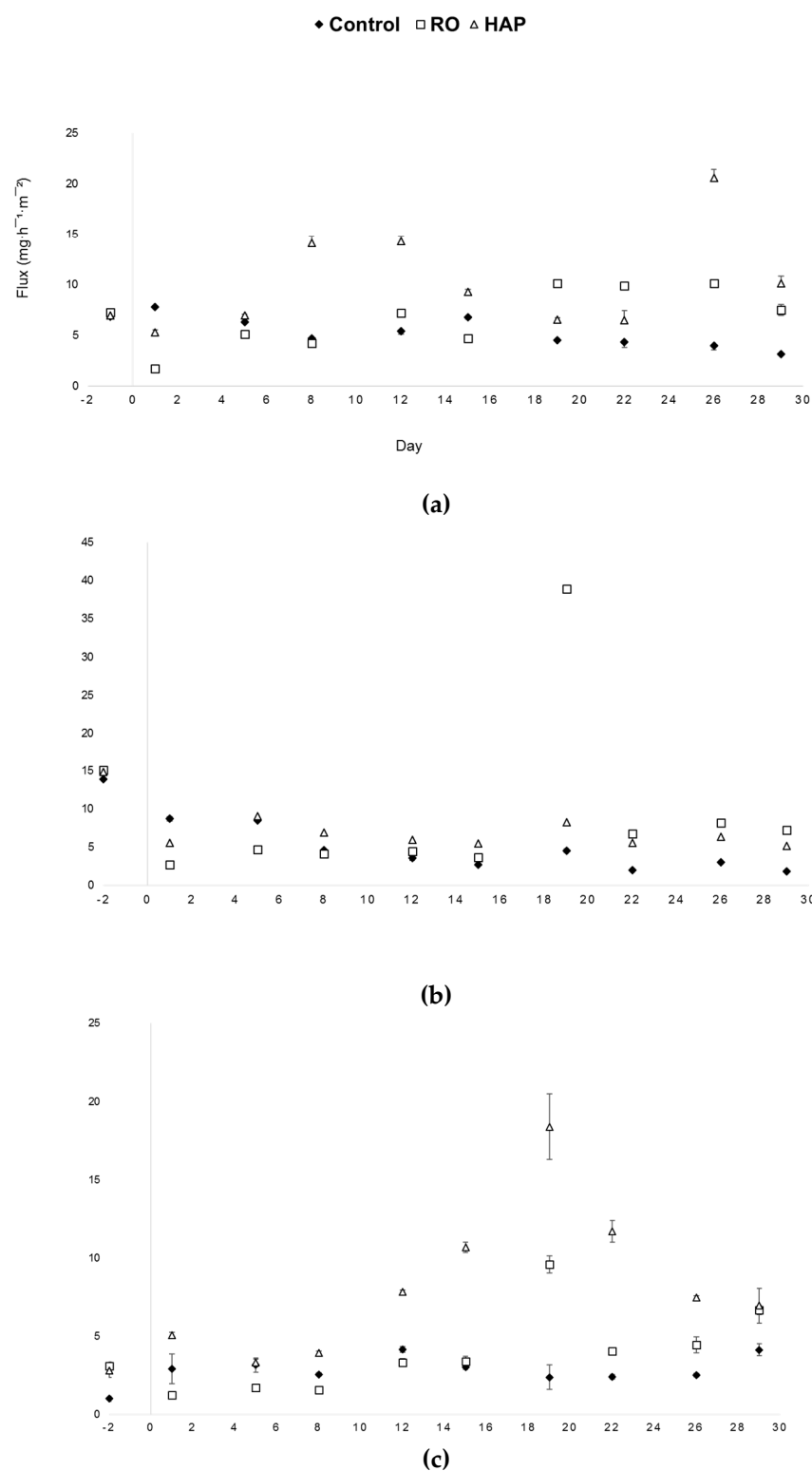


Figure S10. Biochar effect on CH₄ emission from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. ‘-2 day’ data signifies the pre-trial and measurement of emissions before biochar treatment. Note: emitting surface for flux estimation was assumed to be equal to 19 cm × 14.5 cm.

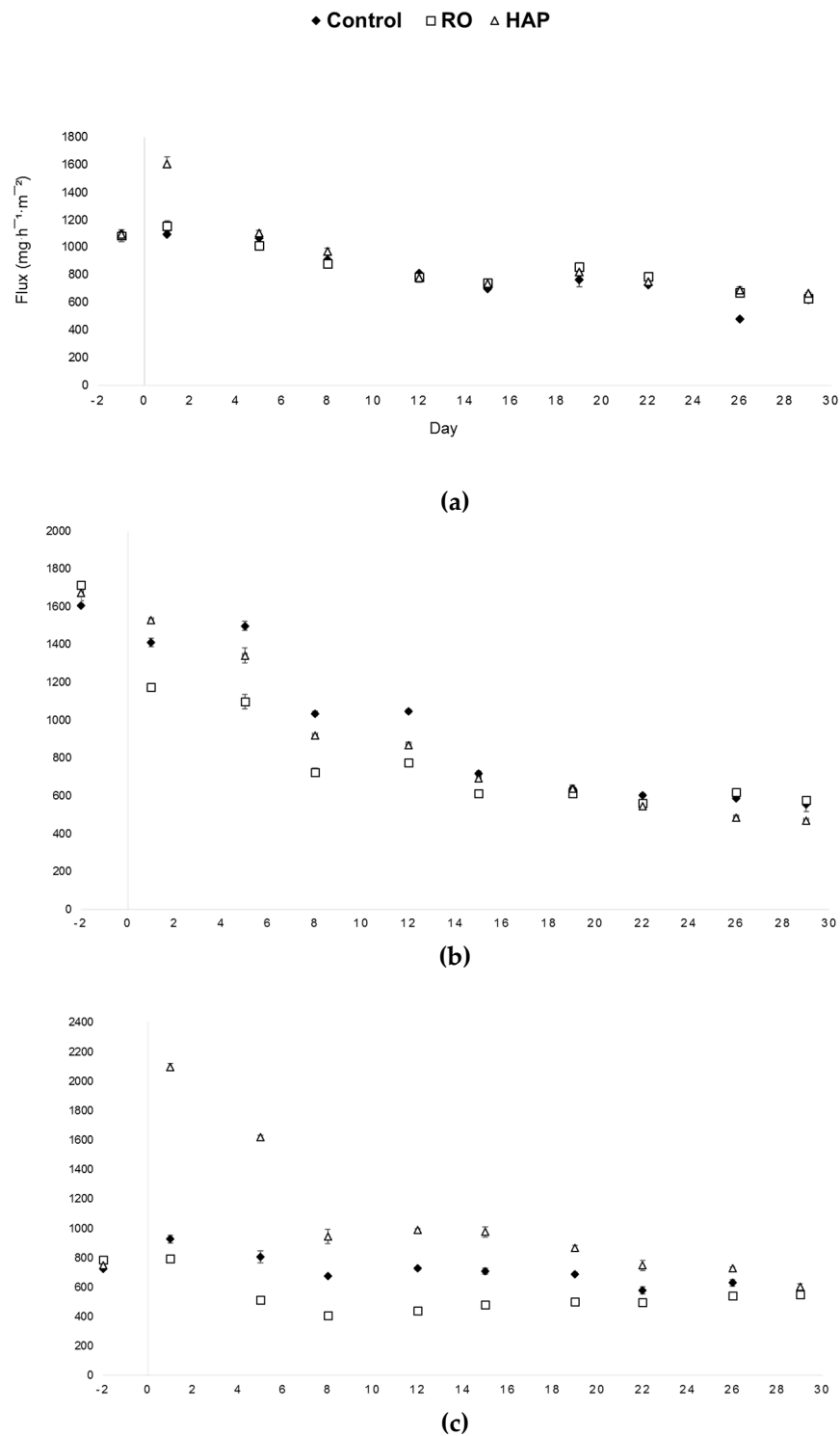
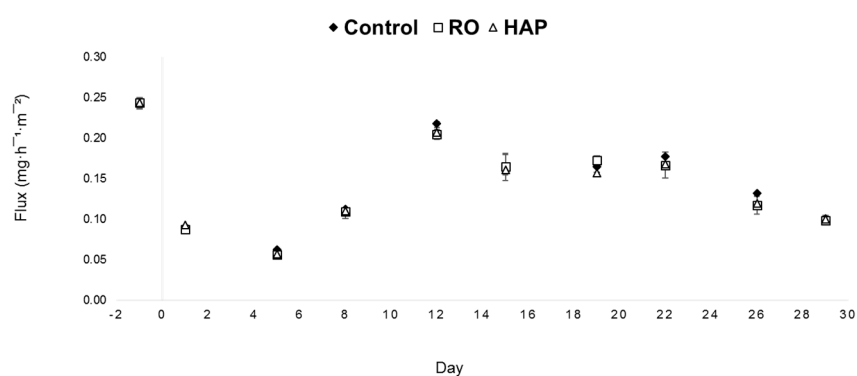
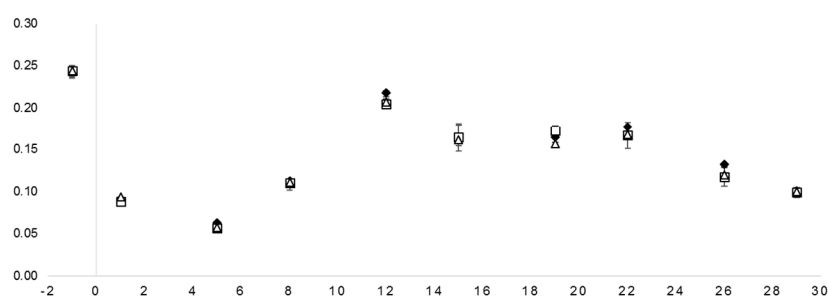


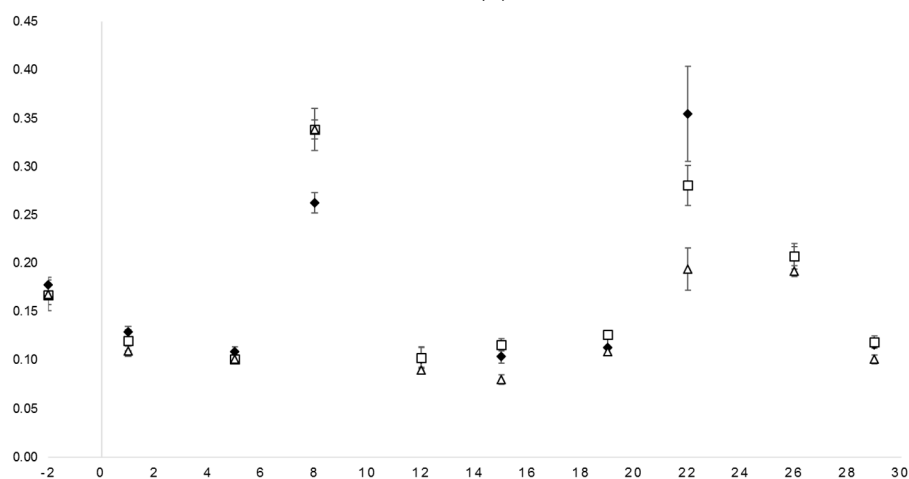
Figure S11. Biochar effect on CO₂ emission from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. ‘-2 day’ data signifies the pre-trial and measurement of emissions before biochar treatment. Note: emitting surface for flux estimation was assumed to be equal to 19 cm × 14.5 cm.



(a)

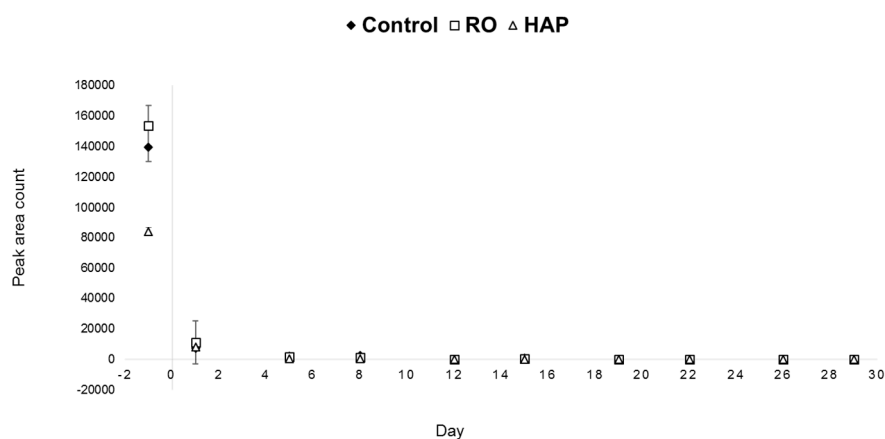


(b)

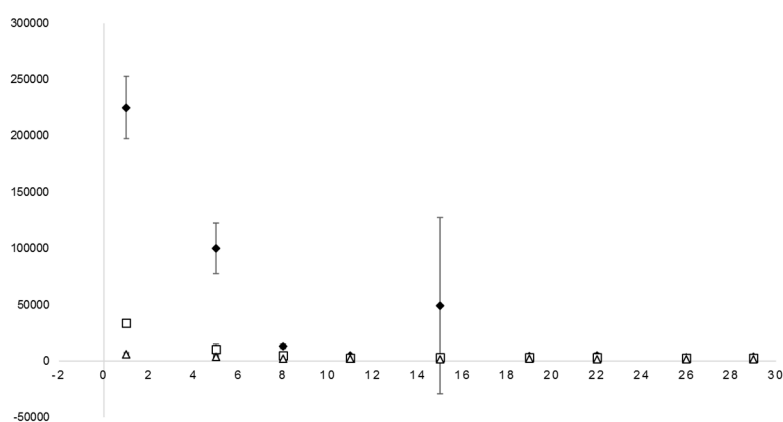


(c)

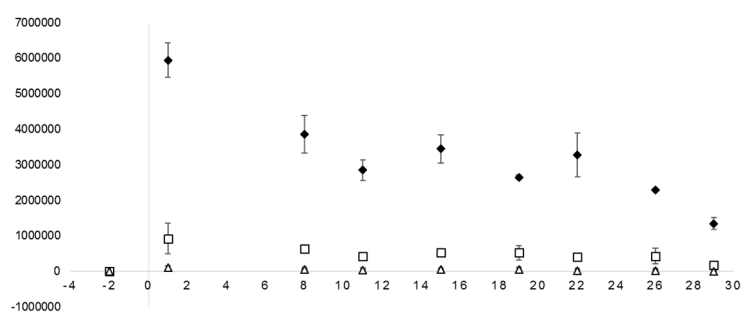
Figure S12. Biochar effect on N₂O emission from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. ‘-2 day’ data signifies the pre-trial and measurement of emissions before biochar treatment. Note: emitting surface for flux estimation was assumed to be equal to 19 cm × 14.5 cm.



(a)



(b)



(c)

Figure S13. Biochar effect on phenol PAC from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. ‘-2 day’ data signifies the pre-trial and measurement of PAC before biochar treatment.

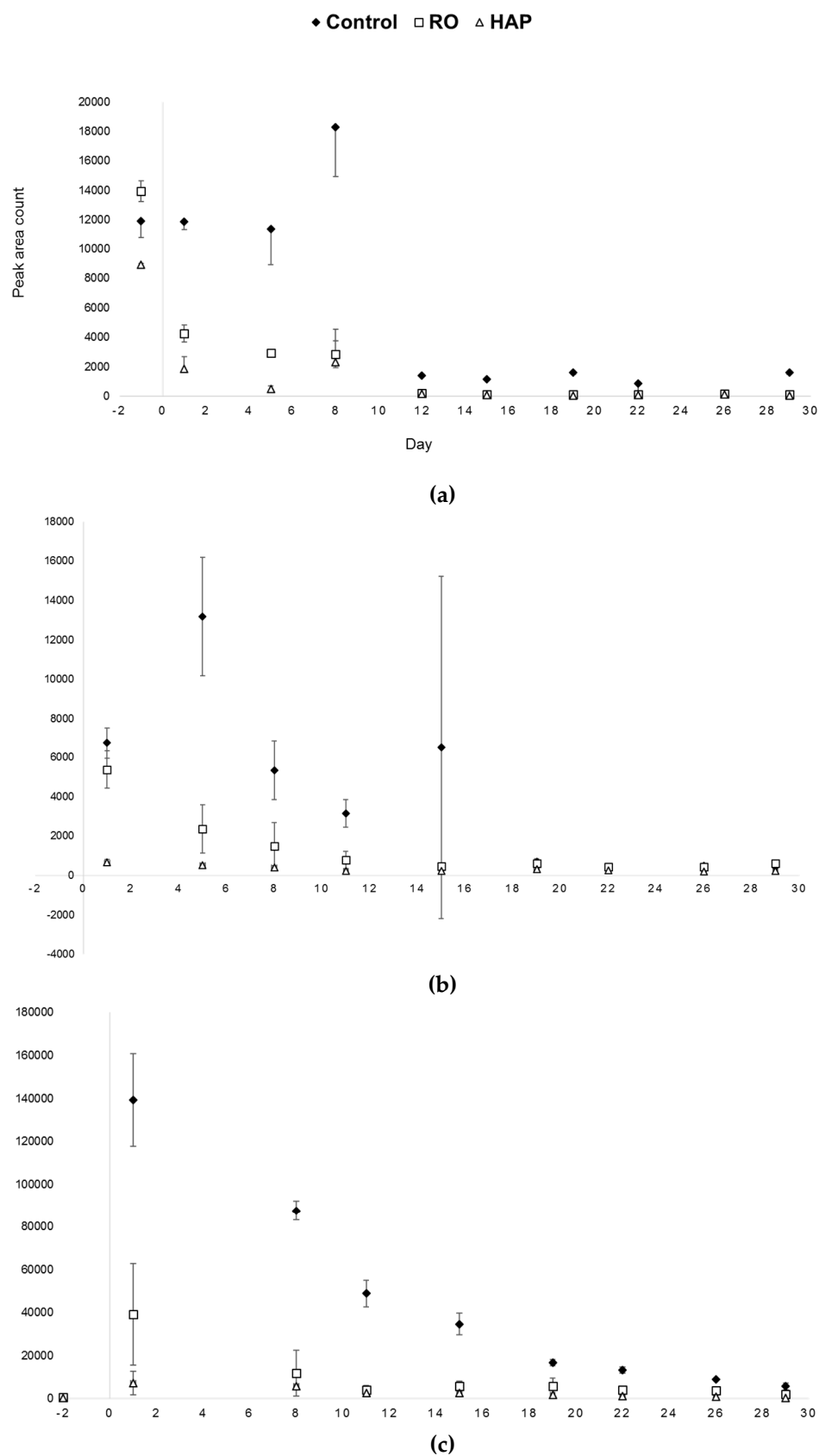


Figure S14. Biochar effect on p-cresol PAC from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. ‘-2 day’ data signifies the pre-trial and measurement of PAC before biochar treatment.

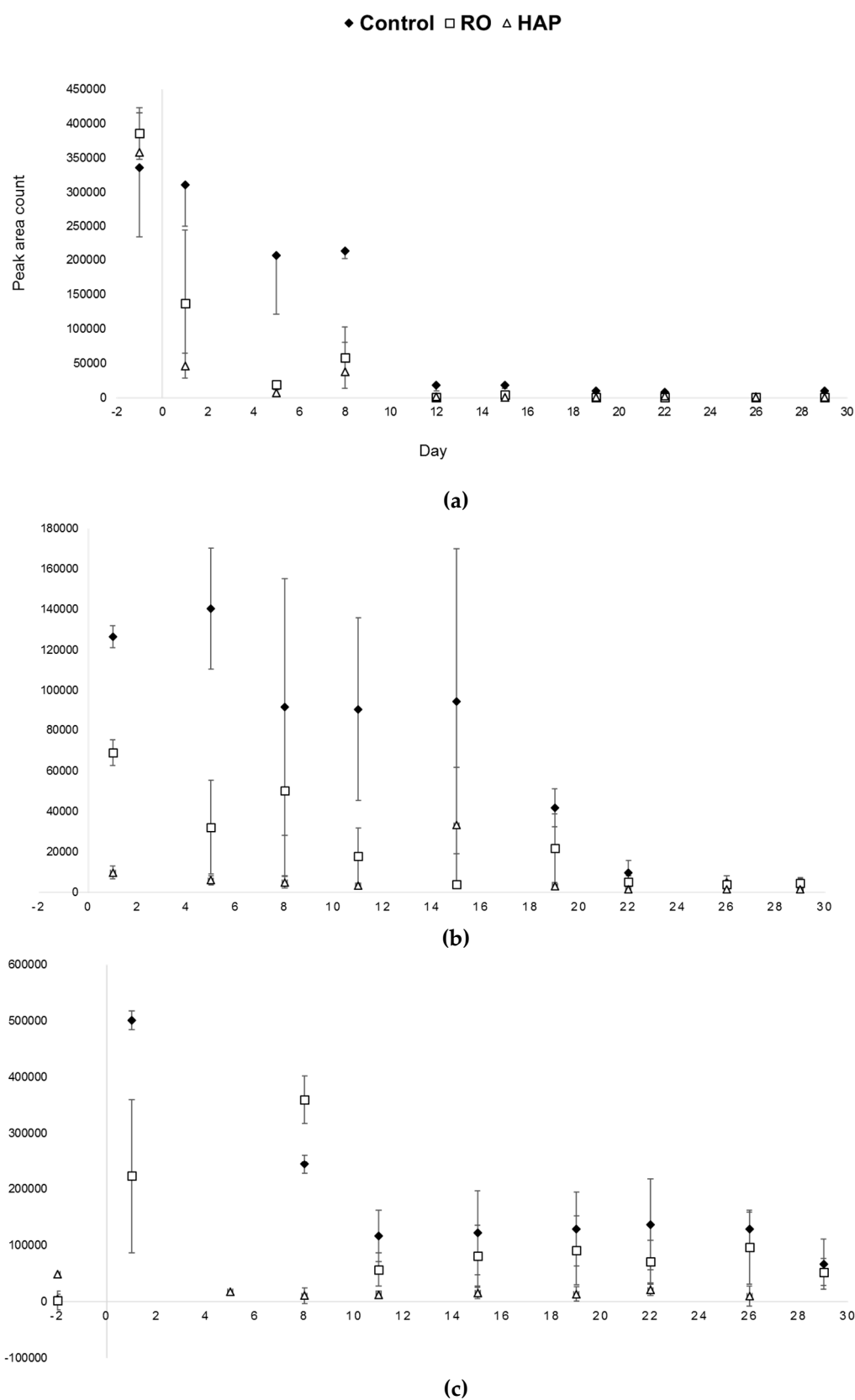


Figure S15. Biochar effect on skatole PAC from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. ‘-2 day’ data signifies the pre-trial and measurement of PAC before biochar treatment.

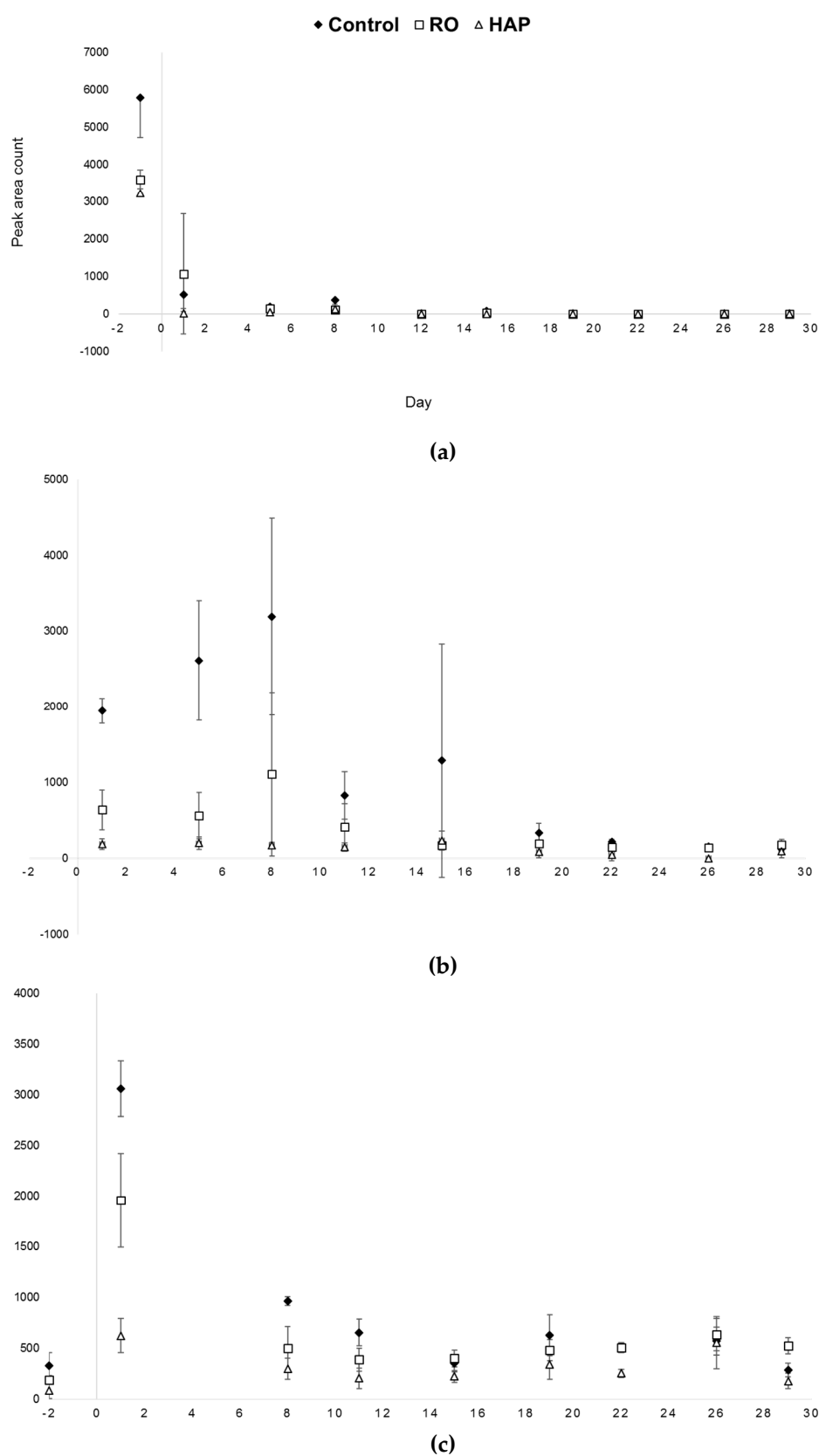


Figure S16. Biochar effect on indole PAC from swine manure: (a) Trial 1; (b) Trial 2; (c) Trial 3. The vertical line on Day 0 represents biochar addition. '-2 day' data signifies the pre-trial and measurement of PAC before biochar treatment.

Table S4. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of NH₃; duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined as the relative difference between control & treatment (Eq. 1). **Bold** signifies statistical significance ($p < 0.05$). A negative value of '% R' signifies generation.

NH ₃	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value
1	483 ± 36	285 ± 77.5	41.0	<0.0001	477 ± 42.7	318 ± 66.7	33.3	<0.0001	431 ± 65.3	320 ± 59.1	25.7	<0.0001	405 ± 77.4	327 ± 55.1	19.3	<0.0001
2	669 ± 40.8	483 ± 62.5	27.8	0.0002	644 ± 54.9	517 ± 58.3	19.8	<0.0001	595 ± 74.0	468 ± 76.0	21.3	<0.0001	544 ± 116	429 ± 89.1	21.2	<0.0001
3	280 ± 265	127 ± 54.7	54.7	0.0013	294 ± 21.6	151 ± 45.0	48.7	<0.0001	293 ± 19.2	169 ± 40.6	42.5	<0.0001	283 ± 26.6	174 ± 38.5	38.5	<0.0001
Average	477 ± 194	298 ± 178	37.5**	0.444	472 ± 174	328 ± 183	30.3**	0.548	440 ± 150	319 ± 149	27.5**	0.548	411 ± 130	310 ± 128	24.5**	0.561

NH ₃	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value
1	483 ± 36	302 ± 37.6	37.5	<0.0001	477 ± 42.7	351 ± 62.2	26.4	<0.0001	431 ± 65.3	337 ± 52.2	22.0	<0.0001	405 ± 77.4	334 ± 47.1	17.5	0.0002
2	669 ± 40.8	474 ± 69.3	29.1	<0.0001	644 ± 54.9	472 ± 56.9	26.7	<0.0001	595 ± 74.0	459 ± 60.2	22.8	<0.0001	544 ± 116	429 ± 78.5	21.2	0.0003
3	280 ± 265	230 ± 85.8	17.9	<0.0001	294 ± 21.6	252 ± 65.3	14.4	0.144	293 ± 19.2	270 ± 52.5	7.9	0.149	283 ± 26.6	272 ± 46.7	4.1	0.510
Average	477 ± 194	335 ± 125	29.7**	0.585	472 ± 174	358 ± 110	24.0**	0.675	440 ± 150	355 ± 95.8	19.2**	0.733	411 ± 130	345 ± 79.0	16.0**	0.927

Note: * an average concentration based on measurements on Day 1 & 5 (First week); an average concentration based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average C_{Con} and C_{Treat} from three Trials.

Table S5. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of H₂S; duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined the relative difference between control & treatment. **Bold** signifies statistical significance ($p < 0.05$). A negative value of '% reduction' signifies generation. .

H ₂ S	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value
1	148 ± 12	119 ± 7	19.9	0.071	139 ± 32	107 ± 21	23.0	0.048	106 ± 59	82 ± 47	22.1	0.449	88 ± 62	68 ± 53	22.5	0.512
2	124 ± 13	79 ± 23	36.5	0.004	132 ± 14	91 ± 28	31.5	0.0003	119 ± 24	80 ± 9	32.6	<0.0001	111 ± 26	89 ± 24	19.4	<0.0001
3	76 ± 15	70 ± 2	8.5	0.456	76 ± 13	59 ± 14	22.6	0.0036	71 ± 12	53 ± 17	25.4	0.0001	69 ± 13	57 ± 17	16.4	0.014
Average	120 ± 40	90 ± 30	23.3**	0.590	120 ± 90	90 ± 20	26.1**	0.493	100 ± 20	70 ± 20	27.1**	0.275	90 ± 7	70 ± 20	19.6**	0.447
H ₂ S	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value
1	148 ± 12	133 ± 20	10.4	0.357	139 ± 32	128 ± 26	8.0	0.622	106 ± 59	84 ± 61	20.1	0.435	88 ± 62	67 ± 63	22.4	0.436
2	124 ± 13	88 ± 23	29.0	0.02	132 ± 14	86 ± 25	35.2	0.0018	119 ± 24	93 ± 23	21.8	0.003	111 ± 26	89 ± 22	19.3	0.0049
3	76 ± 15	71 ± 4	7.2	0.565	76 ± 13	66 ± 8	13.9	0.093	71 ± 12	63 ± 9	10.9	0.14	69 ± 13	67 ± 13	2.4	0.906
Average	120 ± 40	100 ± 30	16.3**	0.763	120 ± 90	90 ± 30	19.6**	0.661	100 ± 20	80 ± 20	18.6**	0.502	90 ± 7	70 ± 10	16.0**	0.559

Note: * an average concentration based on measurements on Day 1 & 5 (First week); an average concentration based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average C_{Con} and C_{Treat} from three Trials.

Table S6. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of CH₄; duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined the relative difference between control & treatment. **Bold** signifies statistical significance ($p < 0.05$). A negative value of '% reduction' signifies generation.

CH ₄	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value
1	47.4 ± 5.6	23.1 ± 12.5	51.4	0.0006	43.6 ± 6.2	32.4 ± 13	26.2	0.239	40 ± 8	42.3 ± 19	-5.7	0.894	36.5 ± 9.8	46.2 ± 18	-26.4	0.254
2	58.2 ± 1.5	25.1 ± 7.5	56.8	<0.0001	43 ± 16.1	27.1 ± 5.5	36.7	0.004	33 ± 17.1	63.1 ± 84	-88.4	0.139	29.7 ± 16	60.7 ± 73	-104.0	0.03
3	20.5 ± 1.9	9.9 ± 1.7	51.6	0.001	21.6 ± 4.3	13.2 ± 5.6	38.8	0.044	19.9 ± 4.1	24 ± 18.4	-20.3	0.831	20.5 ± 4.6	27 ± 17.5	-31.7	0.476
Average	42.1 ± 19.4	19.4 ± 8.2	53.9**	0.0001	36.1 ± 12	24.2 ± 9.8	32.7**	0.004	31.1 ± 10	43.1 ± 19	-38.4**	0.124	28.9 ± 8	44 ± 16.9	-54.2**	0.005
CH ₄	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	HAP* (ppm)	% R	p-value	Control (ppm)	HAP (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value
1	47.4 ± 5.6	41.6 ± 6.2	12.8	0.463	43.6 ± 6.2	56.7 ± 24	-30.0	0.146	40 ± 8	53.9 ± 19	-34.6	0.022	36.5 ± 9.8	65 ± 32.1	-54.6	<0.0001
2	58.2 ± 1.5	49.6 ± 12.8	14.7	0.227	43 ± 16.1	46.5 ± 9.5	-8.12	0.733	33 ± 17.1	45.2 ± 9.3	-34.9	0.7275	29.7 ± 16	43.8 ± 8.8	-40.6	0.47
3	20.5 ± 1.9	28.3 ± 6.5	-37.7	0.012	21.6 ± 4.3	34 ± 12.3	-57.3	0.002	19.9 ± 4.1	58 ± 34.4	-194	<0.0001	20.5 ± 4.6	56 ± 30.5	-221	<0.0001
Average	42.1 ± 19.4	39.8 ± 10.7	5.4**	0.866	36.1 ± 12	45 ± 11.3	-26.8**	0.023	31.1 ± 10	52.7 ± 6.9	-68.9**	0.001	28.9 ± 8	55.2 ± 10	-82.2**	<0.0001

Note: * an average concentration based on measurements on Day 1 & 5 (First week); an average concentration based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average C_{Con} and C_{Treat} from three Trials.

Table S7. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of CO₂; duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined the relative difference between control & treatment. **Bold** signifies statistical significance (p<0.05). A negative value of '% reduction' signifies generation.

CO ₂	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value
1	2656 ± 51	2662 ± 211	-0.2	0.333	2382 ± 304	2353 ± 368	1.2	0.239	2149 ± 366	2150 ± 367	0.0	1.000	2031 ± 395	2026 ± 400	0.2	0.999
2	3578 ± 129	2794 ± 120	21.9	<0.0001	3069 ± 538	2319 ± 505	24.4	0.004	2443 ± 845	1953 ± 574	20.0	0.876	1845 ± 544	1845 ± 544	16.5	0.030
3	2135 ± 179	1612 ± 375	24.5	0.133	1931 ± 250	1327 ± 391	31.2	0.044	1799 ± 261	1279 ± 296	28.8	0.050	1295 ± 262	1295 ± 262	25.1	0.060
Average	2790 ± 730	2356 ± 647	15.5**	0.106	2461 ± 573	2000 ± 582	18.7**	0.029	2130 ± 322	1794 ± 456	15.7**	0.028	1722 ± 381	1722 ± 381	13.5**	0.045
CO ₂	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value
1	2656 ± 51	3334 ± 638	-25.5	0.031	2382 ± 304	2737 ± 795	-14.9	0.146	2149 ± 366	2385 ± 727	-11.0	0.304	2031 ± 395	2225 ± 707	1.7	0.361
2	3578 ± 129	3079 ± 721	13.9	0.899	3069 ± 538	2561 ± 748	16.5	0.873	2443 ± 845	2282 ± 654	6.5	0.003	1845 ± 544	2161 ± 637	0.0	0.470
3	2135 ± 179	4575 ± 641	-114.2	<0.0001	1931 ± 250	3478 ± 122	-80.0	0.002	1799 ± 261	2899 ± 114	-61.1	<0.0001	1295 ± 262	2619 ± 114	-57.3	<0.0001
Average	2790 ± 730	3662 ± 800	-31.2**	0.001	2461 ± 573	2926 ± 486	-18.9**	0.005	2130 ± 322	2522 ± 330	-18.3**	0.007	1722 ± 381	2335 ± 247	-14.9**	0.019

Note: * an average concentration based on measurements on Day 1 & 5 (First week); an average concentration based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average C_{Con} and C_{Treat} from three Trials.

Table S8. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of N₂O; duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined the relative difference between control & treatment. **Bold** signifies statistical significance (p<0.05). A negative value of '% reduction' signifies generation.

N ₂ O	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value	Control* (ppm)	RO* (ppm)	% R	p-value
1	0.18 ± 0.03	0.17 ± 0.04	5.5	0.913	0.29 ± 0.29	0.28 ± 0.14	4.9	0.966	0.34 ± 0.12	0.33 ± 0.12	2.7	0.967	0.33 ± 0.11	0.31 ± 0.11	3.6	0.919
2	0.25 ± 0.03	0.22 ± 0.04	11.1	0.457	0.457 ± 0.24	0.21 ± 0.03	11.2	0.244	0.29 ± 0.09	0.27 ± 0.09	7.8	0.699	0.31 ± 0.09	0.29 ± 0.09	6.9	0.669
3	0.29 ± 0.02	0.27 ± 0.03	6.9	0.394	0.39 ± 0.37	0.40 ± 0.25	-10.1	0.920	0.41 ± 0.28	0.41 ± 0.23	-1.0	0.998	0.40 ± 0.21	0.41 ± 0.20	-0.9	0.997
Average	0.24 ± 0.05	0.22 ± 0.04	8.0**	0.506	0.50 ± 0.30	0.3 ± 0.09	0.4**	0.999	0.35 ± 0.05	0.34 ± 0.07	2.7**	0.942	0.94 ± 0.35	0.34 ± 0.06	2.8**	0.906
N ₂ O	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value	Control* (ppm)	HAP* (ppm)	% R	p-value
1	0.18 ± 0.03	0.18 ± 0.04	0.9	0.997	0.29 ± 0.29	0.28 ± 0.14	3.0	0.987	0.34 ± 0.12	0.34 ± 0.12	1.2	0.990	0.33 ± 0.11	0.32 ± 0.11	-6.3	0.972
2	0.25 ± 0.03	0.22 ± 0.04	12.0	0.401	0.457 ± 0.24	0.22 ± 0.03	8.4	0.419	0.29 ± 0.09	0.27 ± 0.08	8.5	0.657	0.31 ± 0.09	0.28 ± 0.08	2.5	0.604
3	0.29 ± 0.02	0.25 ± 0.01	11.6	0.090	0.39 ± 0.37	0.39 ± 0.26	-6.2	0.969	0.41 ± 0.28	0.35 ± 0.21	12.9	0.730	0.40 ± 0.21	0.35 ± 0.19	45.7	0.653
Average	0.24 ± 0.05	0.22 ± 0.03	9.0**	0.421	0.50 ± 0.30	0.30 ± 0.08	0.7**	0.998	0.35 ± 0.05	0.32 ± 0.04	7.8**	0.613	0.94 ± 0.35	0.32 ± 0.03	23.0**	0.491

Note: * an average concentration based on measurements on Day 1 & 5 (First week); an average concentration based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average C_{Con} and C_{Treat} from three Trials.

Table S9. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of phenol peak area count (PAC); duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined as the relative difference between control & treatment. **Bold** signifies statistical significance ($p < 0.05$). A negative value of '% reduction' signifies generation.

	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value
1	4802 ± 2687	6577 ± 10188	-36.9	0.8958	3096 ± 2704	3038 ± 67	7.8	0.963	1931 ± 2449	2187 ± 5851	-13.2	0.978	1529 ± 228	1726 ± 5206	-12.8	0.979
2	225048 ± 27790	22273 ± 13357	90.7	0.0001	85878 ± 93798	13028 ± 13224	84.8	0.007	57453 ± 82350	9729 ± 11670	83.0	0.004	45522 ± 5724	7471 ± 9982	93.5	0.006
3	5945627 ± 484360	924841 ± 426999	84.4	<0.0001	4816035 ± 1422588	659473 ± 309769	84.3	<0.0001	3671990 ± 1179829	574075 ± 244483	84.3	<0.001	3208962 ± 1327083	506526 ± 258627	84.2	<0.0001
Average	1985077 ± 3429937	317897 ± 52687	84.5**	0.1164	1435003 ± 8800	225180 ± 376142	84.3**	0.002	1243792 ± 2103065	195330 ± 328024	84.2**	<0.001	1085338 ± 189244	171908 ± 289802	84.1**	<0.0001
	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value
1	4802 ± 2687	4262 ± 5472	11.2	0.9898	3096 ± 2704	2316 ± 4219	25.2	0.929	1931 ± 2449	1431 ± 3300	25.9	0.9185	1529 ± 228	1163 ± 2940	59.9	0.9294
2	225048 ± 27790	4930 ± 1115	97.2	<0.0001	85878 ± 93798	3557 ± 1626	95.8	0.0023	57453 ± 82350	2829 ± 1505	95.0	0.0014	45522 ± 75724	2615 ± 1383	83.1	0.0017
3	5945627 ± 484360	101725 ± 58136	98.2	<0.0001	4816035 ± 1422588	63835 ± 42062	98.4	<0.0001	3671990 ± 1179829	52269 ± 38705	98.5	<0.001	3208962 ± 1327083	43198 ± 37664	99.0	<0.0001
Average	1985077 ± 3429937	36972 ± 56078	98.2**	0.0577	1435003 ± 2408800	23236 ± 35165	98.3**	0.0004	1243792 ± 2103065	18843 ± 28956	98.4**	<0.001	1085338 ± 189244	15658 ± 23860	98.9**	<0.0001

Note: * an average PAC based on measurements on Day 1 & 5 (First week); an average PAC based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average PAC_{Com} and PAC_{Treat} from three Trials.

Table S10. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of p-cresol peak area count (PAC); duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined as the relative difference between control & treatment. **Bold** signifies statistical significance ($p < 0.05$). A negative value of '% reduction' signifies generation.

	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value
1	11639 ± 1612	3589 ± 818	69.1	<0.0001	10734 ± 6551	2081 ± 1732	20.6	<0.0001	6652 ± 6857	1526 ± 1705	77.0	0.0005	5368 ± 6502	1221 ± 1605	77.2	0.0006
2	6727 ± 789	3866 ± 1923	42.5	0.002	7098 ± 4179	2506 ± 2013	64.6	0.0006	5149 ± 5105	1848 ± 1882	64.0	0.001	4110 ± 4896	1399 ± 1654	65.9	0.037
3	139281 ± 21614	39257 ± 12594	71.8	0.001	91941 ± 40904	18369 ± 20631	80.0	<0.0001	56768 ± 46335	11792 ± 15769	79.2	0.0001	4497 ± 4562	9574 ± 14132	78.4	0.0001
Average	52549 ± 11793	15571 ± 12842	70.9**	0.021	36591 ± 20552	7652 ± 10830	79.0**	0.001	22856 ± 3314	5055 ± 8069	77.8**	0.0001	17958 ± 22971	4065 ± 7218	77.9**	0.0001
	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value
1	11639 ± 1612	1184 ± 917	89.8	<0.0001	10734 ± 6551	1210 ± 1388	88.7	<0.0001	6652 ± 6857	722 ± 1180	89.1	0.0001	5368 ± 6502	582 ± 1069	97.3	0.0001
2	6727 ± 789	599 ± 125	91.0	<0.0001	7098 ± 4179	462 ± 181	91.4	<0.0001	5149 ± 5105	379 ± 171	92.6	<0.0001	4110 ± 4896	344 ± 169	90.7	<0.0001
3	139281 ± 21614	7354 ± 5506	94.7	0.0003	91941 ± 40904	5324 ± 3456	94.2	<0.0001	56768 ± 46335	3603 ± 3004	93.6	<0.0001	4497 ± 4562	2871 ± 2895	96.7	<0.0001
Average	52549 ± 11793	3046 ± 2905	94.2**	0.665	36591 ± 20552	2332 ± 1656	93.6**	0.0001	22856 ± 23314	1568 ± 14437	93.1**	<0.0001	17958 ± 22971	1266 ± 1388	96.6**	<0.0001

Note: * an average PAC based on measurements on Day 1 & 5 (First week); an average PAC based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average PAC_{Con} and PAC_{Treat} from three Trials.

Table S11. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of skatole peak area count (PAC); duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined as the relative difference between control & treatment. **Bold** signifies statistical significance ($p < 0.05$). A negative value of '% reduction' signifies generation.

	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value
1	258691 ± 87296	77776 ± 94049	69.9	0.002	187296 ± 119432	43818 ± 68637	76.6	0.001	112145 ± 125568	31449 ± 60821	71.9	0.006	88461 ± 119052	24577 ± 54929	72.2	0.0084
2	126649 ± 5394	50591 ± 25213	60.0	<0.0001	112371 ± 42247	42260 ± 29318	62.3	<0.0001	85076 ± 56173	32466 ± 28654	61.8	<0.0001	67227 ± 59889	23192 ± 26774	65.5	0.0002
3	501842 ± 16610	22340 ± 136913	55.4	0.012	289655 ± 171858	21350 ± 259337	26.7	0.6617	208461 ± 149958	14729 ± 193064	29.3	0.403	180701 ± 139763	12903 ± 170721	28.5	0.345
Average	295701 ± 190314	117257 ± 92924	60.3**	0.0004	195774 ± 7949	99862 ± 98422	48.9**	0.0009	135227 ± 4850	70402 ± 66588	47.9**	0.001	112130 ± 60326	58936 ± 60715	47.3**	0.0376
	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value
1	258691 ± 87296	26806 ± 24166	89.6	0.0002	187296 ± 119432	23150 ± 28264	87.6	0.0001	112145 ± 125568	13750 ± 23751	87.7	0.0007	88461 ± 119052	10793 ± 21581	94.8	0.001
2	126649 ± 5394	7972 ± 3226	93.7	<0.0001	112371 ± 42247	6102 ± 3269	94.5	<0.0001	85076 ± 56173	8939 ± 13887	89.4	<0.0001	67227 ± 59889	7321 ± 12567	74.4	<0.0001
3	501842 ± 16610	48571 ± 16772	90.3	0.001	289655 ± 171858	25657 ± 20954	91.0	0.0135	208461 ± 149958	19556 ± 17013	90.6	0.0006	180701 ± 139763	18409 ± 16070	93.0	0.0001
Average	295701 ± 190314	27783 ± 20317	90.6**	<0.0001	195774 ± 87949	18303 ± 10640	90.6**	<0.0001	135227 ± 64850	14082 ± 5319	89.5**	<0.0001	112130 ± 60326	12174 ± 5671	92.7**	<0.0001

Note: * an average PAC based on measurements on Day 1 & 5 (First week); an average PAC based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average PAC_{Con} and PAC_{Treat} from three Trials.

Table S12. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of indole peak area count (PAC); duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined as the relative difference between control & treatment. **Bold** signifies statistical significance ($p < 0.05$). A negative value of '% reduction' signifies generation.

	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value
1	365 ± 307	613 ± 1134	-68.0	0.804	282 ± 262	277 ± 736	1.9	0.959	177 ± 232	200 ± 628	-12.7	0.980	142 ± 214	158 ± 556	-11.2	0.984
2	1946 ± 166	599 ± 257	69.1	<0.0001	2143 ± 1133	681 ± 574	68.2	0.0001	1972 ± 514	514 ± 522	73.9	0.0003	1188 ± 1263	394 ± 457	66.8	0.001
3	3064 ± 275	1958 ± 462	36.0	0.014	17644 ± 23663	2164 ± 1851	87.7	0.062	9070 ± 18475	1314 ± 1543	85.5	0.086	6946 ± 16323	1145 ± 1361	83.5	0.092
Average	191 ± 1356	1057 ± 780	40.9**	0.045	6690 ± 9532	1041 ± 993	84.4**	0.052	4702 ± 676	676 ± 574	81.9**	0.0495	2758 ± 3663	565 ± 515	79.4**	0.052
	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value
1	4802 ± 2687	41 ± 45	88.7	0.692	3096 ± 2704	54 ± 56	80.9	0.054	1931 ± 2449	34 ± 47	80.5	0.460	1529 ± 228	29 ± 43	94.1	0.455
2	225048 ± 27790	192 ± 69	90.0	<0.0001	85878 ± 93798	175 ± 59	91.7	<0.0001	57453 ± 82350	152 ± 91	92.2	<0.0001	45522 ± 75724	129 ± 97	92.4	<0.0001
3	5945627 ± 484360	625 ± 168	79.5	0.0002	4816035 ± 1422588	1211 ± 1142	93.7	0.045	3671990 ± 1179829	742 ± 922	91.8	0.060	3208962 ± 1327083	696 ± 804	28.5	0.064
Average	1985077 ± 3429937	286 ± 303	84.0**	0.0002	1435003 ± 2408800	480 ± 635	92.8**	0.026	1243792 ± 2103065	310 ± 379	91.7**	0.022	1085338 ± 189244	284 ± 359	73.2**	0.023

Note: * an average PAC based on measurements on Day 1 & 5 (First week); an average PAC based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average PAC_{Con} and PAC_{Treat} from three Trials.

Table S13. Biochar (top table: RO; bottom table: HAP) effect on mitigation of isobutyric acid peak area count (PAC); duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined as the relative difference between control & treatment. **Bold** signifies statistical significance ($p < 0.05$). Negative value of '% reduction' signifies generation.

	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value	Control* (PAC)	RO* (PAC)	% R	p-value
1	526 ± 265	846 ± 571	-60.8	0.350	559 ± 475	425 ± 507	23.8	0.981	338 ± 439	311 ± 463	8.1	0.972	272 ± 405	248 ± 424	8.5	0.969
2	429 ± 42	589 ± 167	-37.2	0.171	7411 ± 76	461 ± 179	-12.0	0.852	443 ± 145	394 ± 184	11.1	0.571	432 ± 139	355 ± 165	17.8	0.328
3	639 ± 207	519 ± 187	18.8	0.683	613 ± 129	409 ± 129	33.3	0.002	563 ± 127	405 ± 101	28.0	0.0001	522 ± 142	385 ± 102	26.2	0.0002
Average	531 ± 105	651 ± 172	-22.5**	0.262	104 ± 432	432 ± 26	18.1**	0.788	448 ± 112	370 ± 51	17.4**	0.267	409 ± 126	329 ± 71	19.3**	0.171
	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value	Control* (PAC)	HAP* (PAC)	% R	p-value
1	526 ± 265	359 ± 230	31.7	0.739	559 ± 475	334 ± 268	40.1	0.426	338 ± 439	205 ± 251	39.1	0.527	272 ± 405	171 ± 230	87.5	0.569
2	429 ± 42	396 ± 95	7.50	0.586	7411 ± 76	592 ± 338	-44.0	0.136	443 ± 145	472 ± 291	-6.4	0.902	432 ± 139	436 ± 266	8.0	0.997
3	639 ± 207	338 ± 99	47.0	0.160	613 ± 129	416 ± 83	32.1	0.003	563 ± 127	432 ± 77	23.1	0.001	522 ± 142	413 ± 80	46.9	0.003
Average	531 ± 105	364 ± 29	31.3**	0.266	104 ± 432	447 ± 131	15.1**	0.627	448 ± 112	370 ± 143	17.4**	0.310	409 ± 126	340 ± 146	61.2**	0.263

Note: * an average PAC based on measurements on Day 1 & 5 (First week); an average PAC based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average PAC based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average PAC_{Con} and PAC_{Treat} from three Trials.

Table S14. Biochar (top table: RO; bottom table: HAP) effect on the mitigation of odor concentration (OU/m³); duration of treatment effectiveness. The mitigation effect is expressed as the % reduction (% R) defined as the relative difference between control & treatment. **Bold** signifies statistical significance (p<0.05). A negative value of '% reduction' signifies generation.

	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (OU/m ³)	RO* (OU/m ³)	% R	p-value	Control* (OU/m ³)	RO* (OU/m ³)	% R	p-value	Control* (OU/m ³)	RO* (OU/m ³)	% R	p-value	Control* (OU/m ³)	RO* (OU/m ³)	% R	p-value
1	265 ± 225	300 ± 47	-13.2	0.216	357 ± 118	296 ± 38	17.1	0.151	385 ± 113	311 ± 46	19.1	0.008	386 ± 112	320 ± 50	17.1	0.025
2	286 ± 50	213 ± 22	25.3	0.096	418 ± 201	357 ± 174	14.6	0.645	375 ± 166	301 ± 162	19.8	0.507	365 ± 157	287 ± 142	21.3	0.287
3	327 ± 66	257 ± 28	21.5	0.042	270 ± 76	219 ± 47	18.8	0.148	312 ± 165	212 ± 78	31.9	0.188	314 ± 155	218 ± 76	30.2	0.139
Average	293 ± 31	257 ± 43	12.3**	0.121	348 ± 74	290 ± 69	16.6**	0.121	357 ± 39	275 ± 54	23.1**	0.565	355 ± 37	275 ± 51	22.4**	0.008
	First week				First 2 weeks				First 3 weeks				Over the trial			
Trial #	Control* (OU/m ³)	HAP* (OU/m ³)	% R	p-value	Control* (OU/m ³)	HAP* (OU/m ³)	% R	p-value	Control* (OU/m ³)	HAP* (OU/m ³)	% R	p-value	Control* (OU/m ³)	HAP* (OU/m ³)	% R	p-value
1	265 ± 225	268 ± 26	-1.3	0.983	357 ± 118	304 ± 68	14.9	0.259	385 ± 113	328 ± 78	14.6	0.037	320 ± 50	338 ± 83	-31.1	0.143
2	286 ± 50	270 ± 28	5.6	0.798	418 ± 201	345 ± 113	17.3	0.543	375 ± 166	421 ± 235	-12.1	0.613	287 ± 142	412 ± 221	-11.6	0.633
3	327 ± 66	186 ± 31	43.1	0.0002	270 ± 76	239 ± 67	11.4	0.480	312 ± 165	349 ± 255	-11.8	0.732	218 ± 76	336 ± 241	-59.3	0.895
Average	293 ± 31	241 ± 47	17.5**	0.019	348 ± 74	296 ± 53	15.0**	0.019	357 ± 39	366 ± 48	-2.4**	0.919	275 ± 51	362 ± 43	-29.6**	0.799

Note: * an average concentration based on measurements on Day 1 & 5 (First week); an average concentration based on measurements on Day 1, 5, 8 & 12 (First 2 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19 & 22 (First 3 weeks); an average concentration based on measurements on Day 1, 5, 8, 12, 15, 19, 22, 26 & 29 (Entire trial). ** The average % R (Avg % R) was estimated based on the average C_{Con} and C_{Treat} from three Trials.