

Combined Toxicity of Multi-Walled Carbon Nanotubes and Cu²⁺ on the Growth of Ryegrass: Effect of Surface Modification, Dose, and Exposure Sequence

Wenwen Xie¹, Cheng Peng^{1,2*}, Weiping Wang¹, Xiaoyi Chen¹, Jiaqi Tan^{3*}, and Wei Zhang¹

- ¹ State Environmental Protection Key Laboratory of Environmental Risk Assessment and Control on Chemical Process, School of Resource and Environmental Engineering, East China University of Science and Technology, Shanghai 200237, China
 - ² Shanghai Institute of Pollution Control and Ecological Security, Shanghai 200092, China
 - ³ Department of Biological Sciences, Louisiana State University, Baton Rouge, LA 70803, USA
- * Correspondence: (cpeng@ecust.edu.cn); Jiaqi Tan (jtan7@lsu.edu).

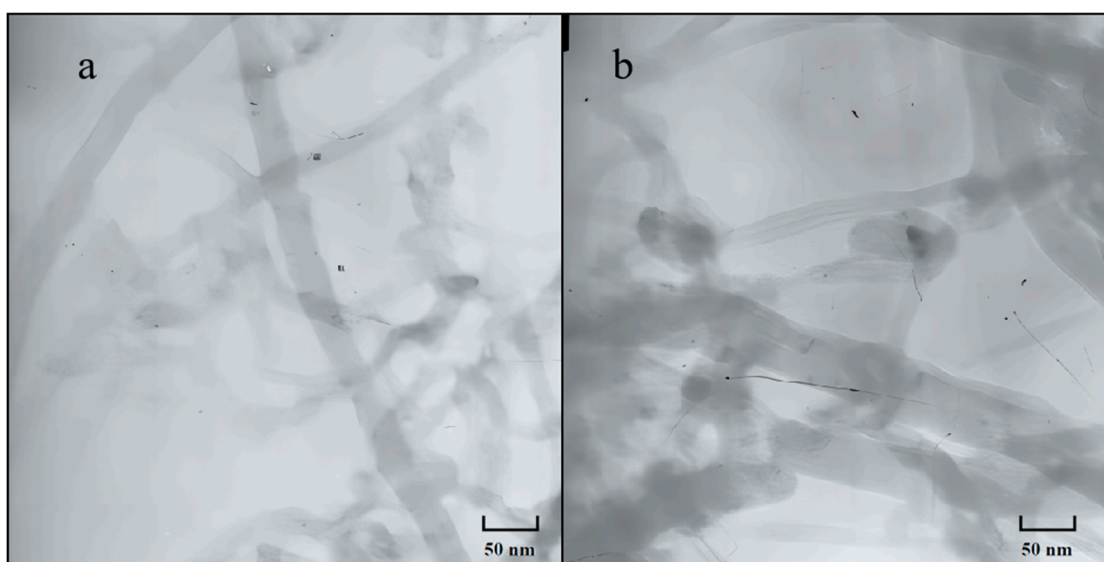


Figure S1. TEM images of (a) MWCNT; (b) MWCNT-COOH.

Citation: To be added by editorial staff during production.

Academic Editor: Fernanda Cássio

Received: 27 August 2024

Revised: 27 October 2024

Accepted: 28 October 2024

Published: 30 October 2024



Copyright: © 2024 by the authors. Submitted for possible open access publication under the terms and conditions of the Creative Commons Attribution (CC BY) license (<https://creativecommons.org/licenses/by/4.0/>).

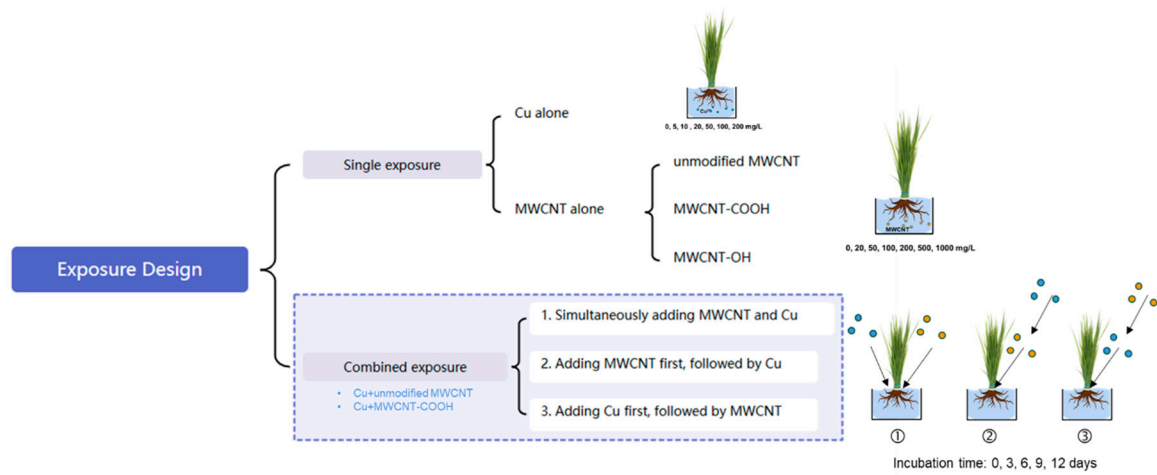


Figure S2. Exposure design of the study

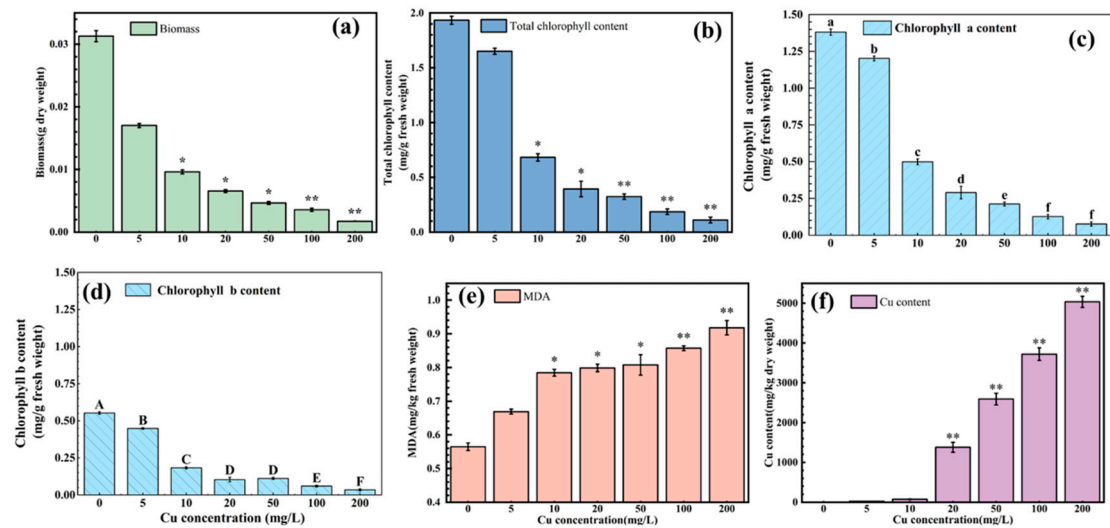


Figure S3. Comparison of the effects of Cu^{2+} on ryegrass: biomass (a), total chlorophyll content (b), chlorophyll a content (c), chlorophyll b content (d), MDA content (e) of the ryegrass and the Cu^{2+} concentration in the root of the ryegrass (f). (The asterisk * indicates a significance level of $p < 0.05$ and ** indicates $p < 0.01$, as revealed using one-way analysis of variance (ANOVA) followed by the Turkey's post-hoc test.)

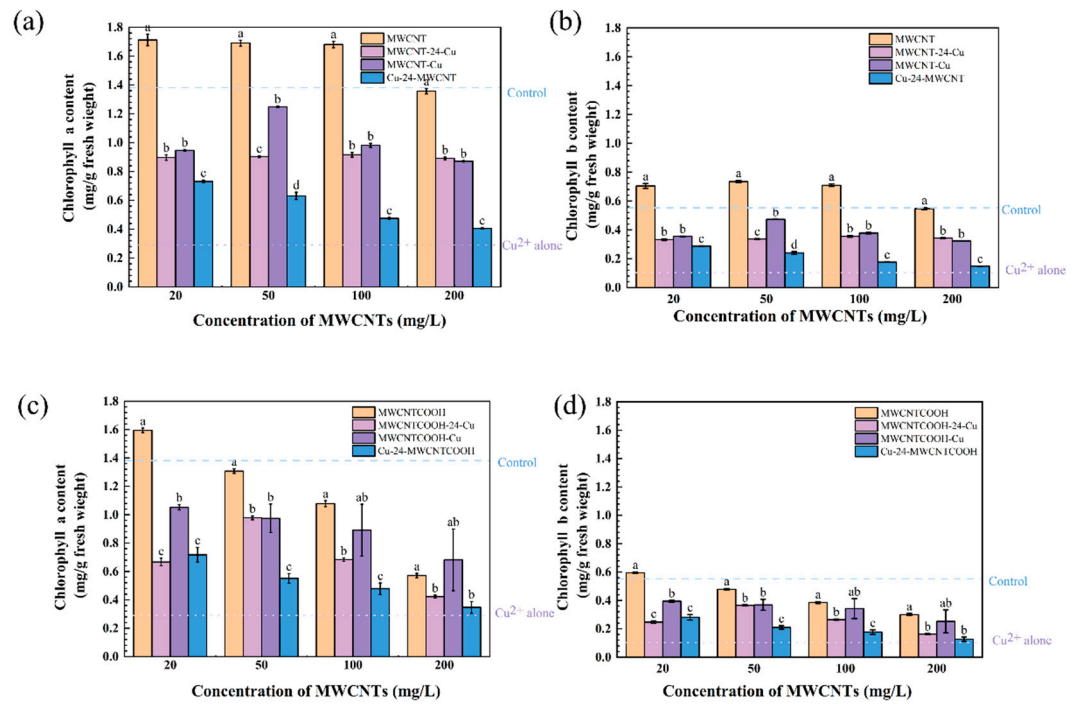


Figure S4. Impact of MWCNT concentration under combined effects on chlorophyll a content (a and c) and chlorophyll b content (b and d) of unmodified MWCNT (a and b), and MWCNT-COOH (c and d). The dot line represents the value of the control group (treated with only Cu²⁺ and without MWCNT). The dashed line represents the value of the Cu²⁺-alone group (treated without MWCNT and Cu²⁺). Different letters denote the significant difference ($p < 0.05$) across treatments at the same concentration, as revealed using one-way analysis of variance (ANOVA) followed by the Duncan's post-hoc test.

Table S1. Pearson Correlation Analysis of MWCNT Concentration and Chlorophyll Content in Ryegrass

Treatments		MWCNTs concentration	
MWCNTCOOH-24-Cu	Pearson Correlation		-0.94*
	Sig. (2-tailed)		0.017
	N		5
MWCNTCOOH-Cu	Pearson Correlation		-0.234
	Sig. (2-tailed)		0.704
	N		5
Cu-24-MWCNTCOOH	Pearson Correlation		-0.777
	Sig. (2-tailed)		0.122
	N		5
MWCNT-24-Cu	Pearson Correlation		-0.920*

	Sig. (2-tailed)	0.027
	N	5
	Pearson Correlation	-0.772
MWCNT-Cu	Sig. (2-tailed)	0.126
	N	5
	Pearson Correlation	-0.77
Cu-24-MWCNT	Sig. (2-tailed)	0.128
	N	5

The symbol * indicates a significant correlation at the 0.05 level (two-tailed).