Comparing the inhibitory effects of CuO-rGO, CuO NPs, and CuCl₂ on the oomycete Phytophthora sojae: Insights from phenotypic and transcriptomic analyses

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Mycelial growth inhibition assay

In our mycelium growth pre-experiment, we tested various concentrations of Cu$^{2+}$ (0, 10, 25, 50, 100, 250, and 500 mg L$^{-1}$). We observed complete inhibition of \textit{P. sojae} growth in colony size over 50 mg Cu$^{2+}$ L$^{-1}$, indicating a strong inhibitory impact of \textit{P. sojae} growth. Meanwhile, we used 50 mg L$^{-1}$ single rGO as a positive control. We found single rGO had no significant inhibitory effect on \textit{P. sojae}. This mean that the inhibitory effects on \textit{P. sojae} are attribute to different forms copper and its released ions. So, we only compare the differences of CuO-rGO, CuO, and CuCl$_2$ in this study, and selected the concentrations of 0, 10, 25, 50 mg Cu$^{2+}$ L$^{-1}$. 
**Fig. S1** Transmission electron microscope (TEM) images of (A) CuO-rGO and (B) CuO NPs. The red and blue arrows indicate the rGO nanosheets and CuO NPs, respectively. X-ray diffractometer (XRD) patterns of CuO-rGO and CuO NPs (C). X-ray photoelectron spectroscopy (XPS) full spectrum of CuO-rGO and CuO NPs (D). The specific (E) C 1s and (F) Cu 2p spectrum of CuO-rGO.
Fig. S2 The dispersion of CuO-rGO and CuO NPs at the concentration of 50 mg Cu$^{2+}$ L$^{-1}$ in water after ultrasonic dispersion and standing for 0 and 1 day.
Fig. S3 The mycelium ROS level of *P. sojae* in (A) Control, (B) CuO-rGO, (C) CuO NPs, and (D) CuCl$_2$ treatments at 10 mg Cu$^{2+}$ L$^{-1}$ level
Fig. S4 GO enrichment analysis of DEGs in (A) CuO-rGO, (B) CuO NPs, and (C) CuCl₂ treatments compared to the control at 10 mg Cu²⁺ L⁻¹ level.