

**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 *P. sojae* growth in colony size over 50 $\text{mg Cu}^{2+} \text{L}^{-1}$, indicating a strong inhibitory impact of *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 *P. sojae*. This mean that the inhibitory effects on *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 $\text{mg Cu}^{2+} \text{L}^{-1}$.

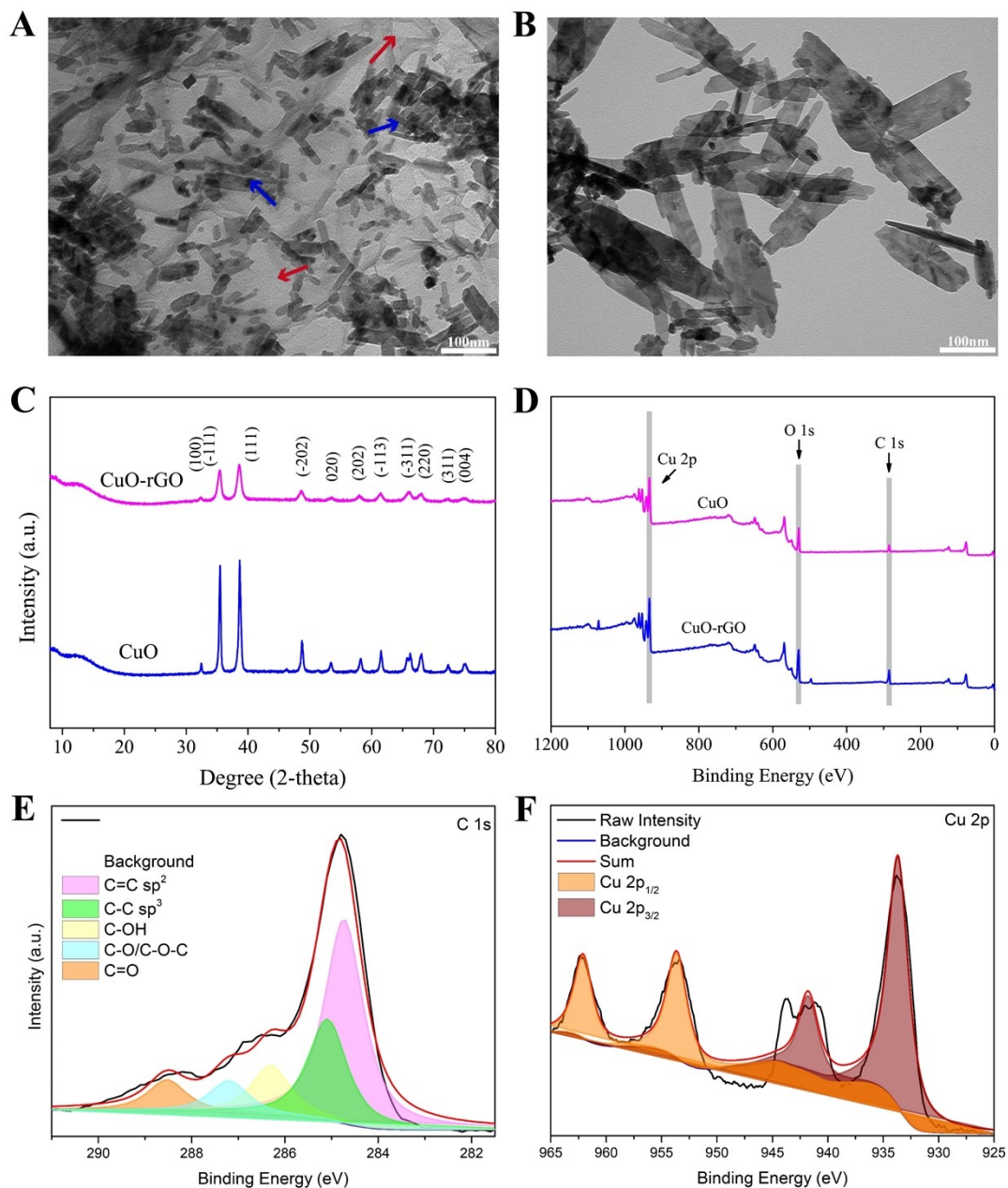


Fig. S1 Transmission electron microscope (TEM) images of (A) CuO-rGO and (B) CuO NPs. The red and blue arrows indicate the rGO nanosheets and CuO NPs, respectively. X-ray diffractometer (XRD) patterns of CuO-rGO and CuO NPs (C). X-ray photoelectron spectroscopy (XPS) full spectrum of CuO-rGO and CuO NPs (D). The specific (E) C 1s and (F) Cu 2p spectrum of CuO-rGO.

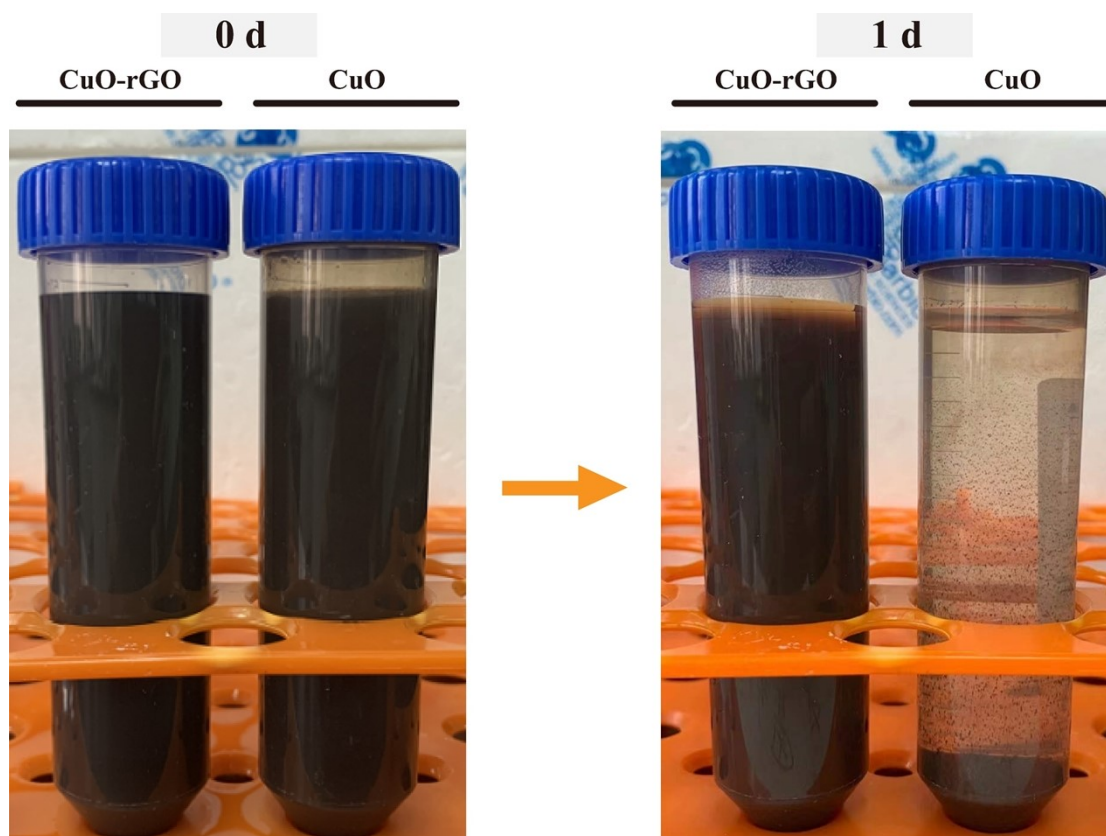


Fig. S2 The dispersion of CuO-rGO and CuO NPs at the concentration of $50 \text{ mg Cu}^{2+} \text{ L}^{-1}$ in water after ultrasonic dispersion and standing for 0 and 1 day.

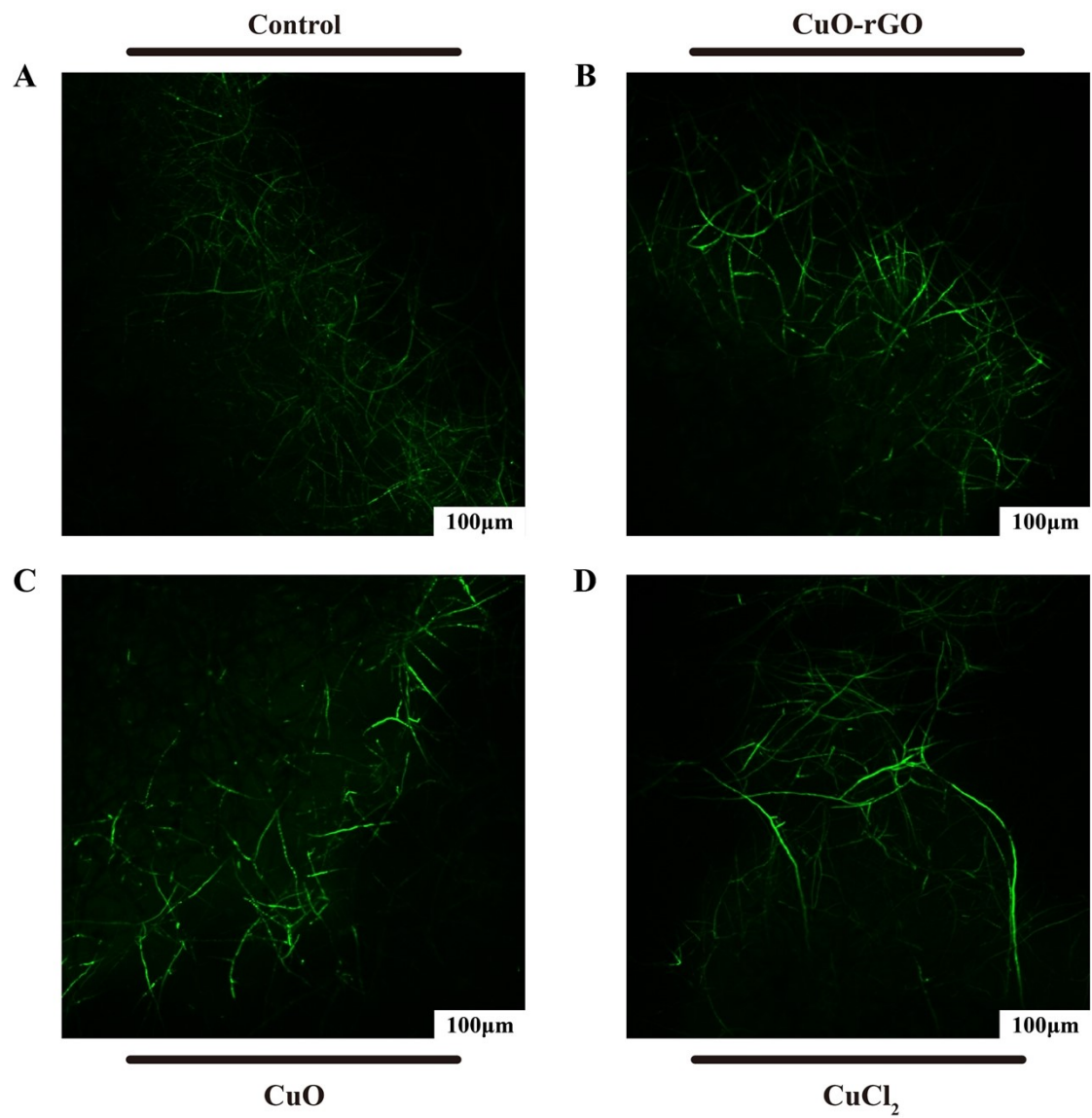


Fig. S3 The mycelium ROS level of *P. sojae* in (A) Control, (B) CuO-rGO, (C) CuO NPs, and (D) CuCl₂ treatments at 10 mg Cu²⁺ L⁻¹ level

