

## Supplementary Information

### **Manganese-based nanozyme enables efficient mitigation of Huanglongbing-induced oxidative damage in *Citrus***

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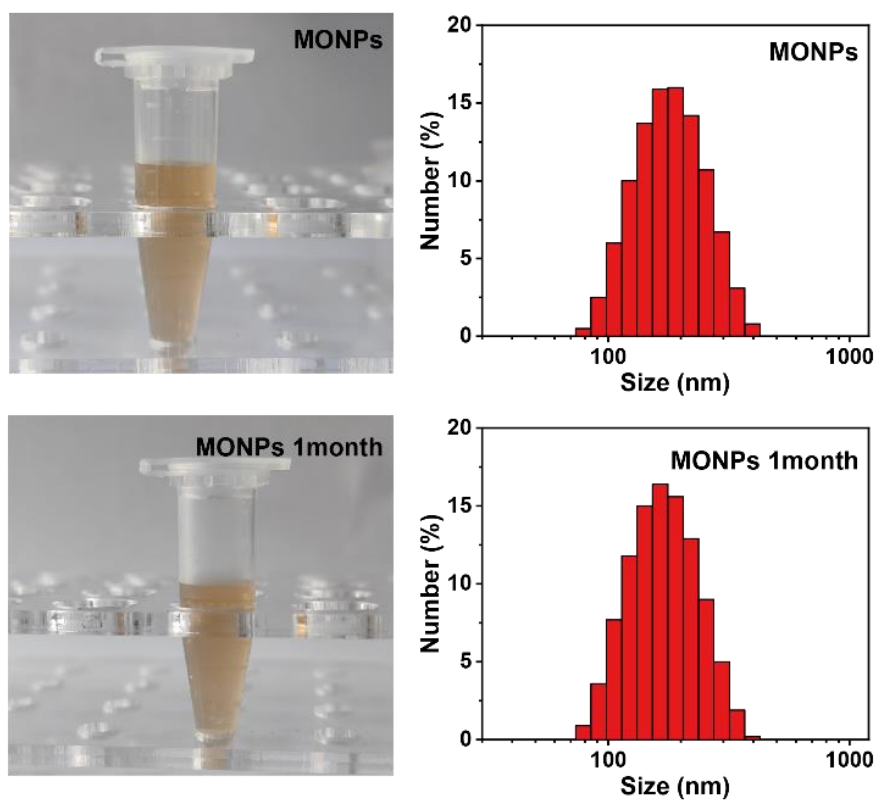
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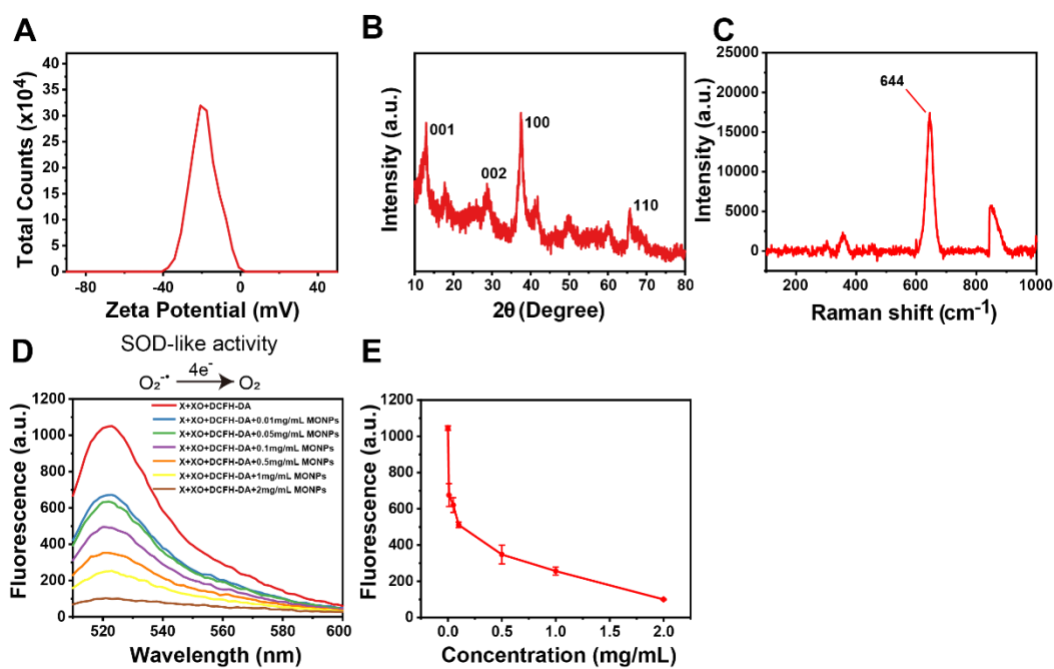
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**Table S1.** Primers used in this study.

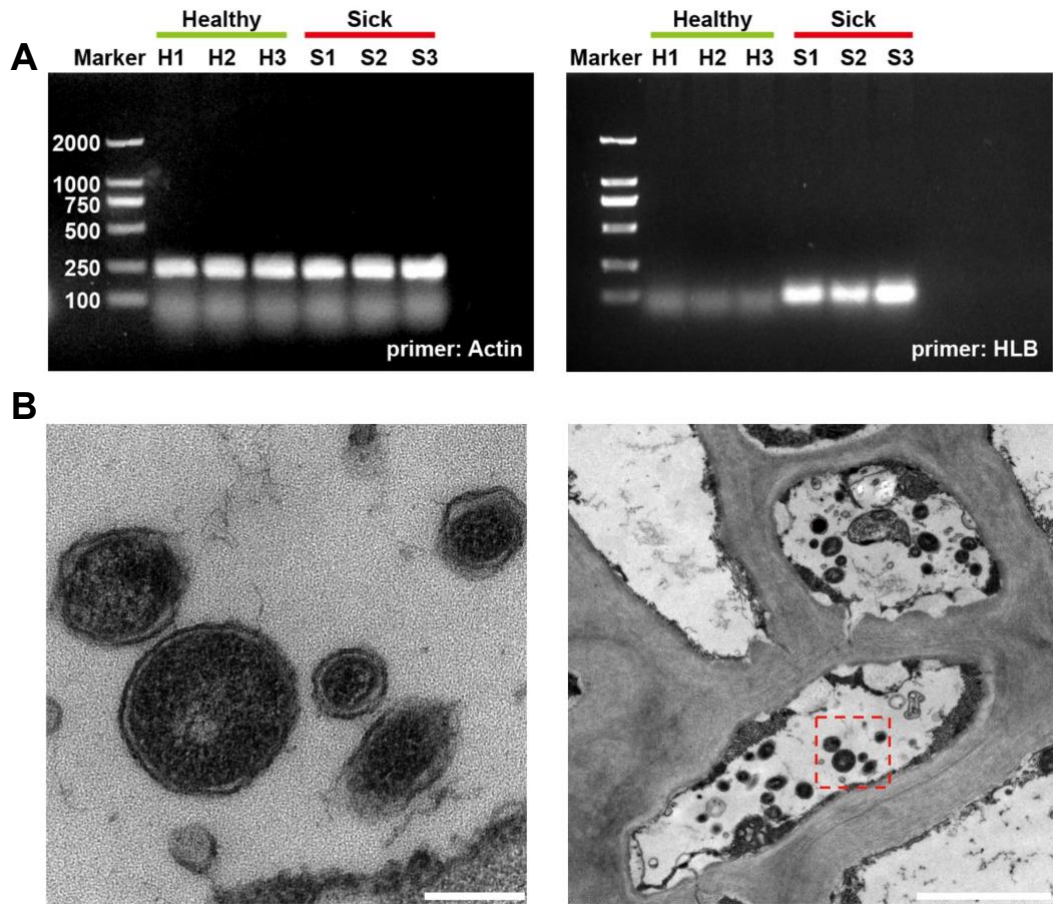
<b>Name</b>	<b>Sequence</b>
Cs6226SOD-F	GCTATAGGCTTGGGTAAATC
Cs6226SOD-R	CCGCCTTGTTGTAGTTAGTA
Cs6642SOD-F	GGCTCACGTTCTCCTCGTAG
Cs6642SOD-R	ATTTGAGGGAGACGCCGTG
Cs2588SOD-F	CAGTTTGGATATGTGGGAGC
Cs2588SOD-R	GGTTTCGCCTAAATTCACGA
Cs6866CAT-F	AATCCCTGACATGGTCCAT
Cs6866CAT-R	AACACCAGATCCTTCCATGT
Cs5999CAT-F	ACAGCCACGCTACTCAGGAT
Cs5999CAT-R	TGTTCAAGACCAAGCGTCCA
Cs0069RBOH-F	AGCAACTCGTTGGTTCAGAA
Cs0069RBOH-R	GTAATATGCCGTGGACGATG
Actin-F	TCCAAGCAGCATGAAGATCAA
Actin-R	CAGACTCATCATACTCGCCCT
HLB-F	ACCAGTTCTTATTCCATTCGCCC
HLB-R	TCACAATCATGTTTTTCAAGCCAA



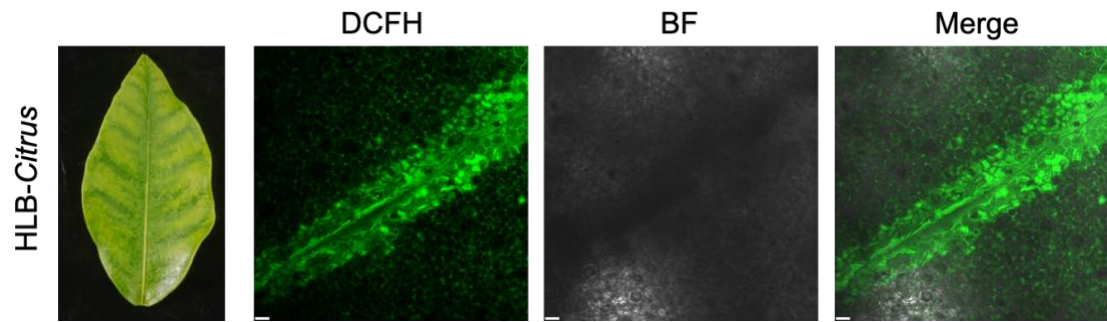
**Figure S1.** The stability of MONPs for long-term storage. The MONPs supernatant and DLS did not change after 1 month storage.



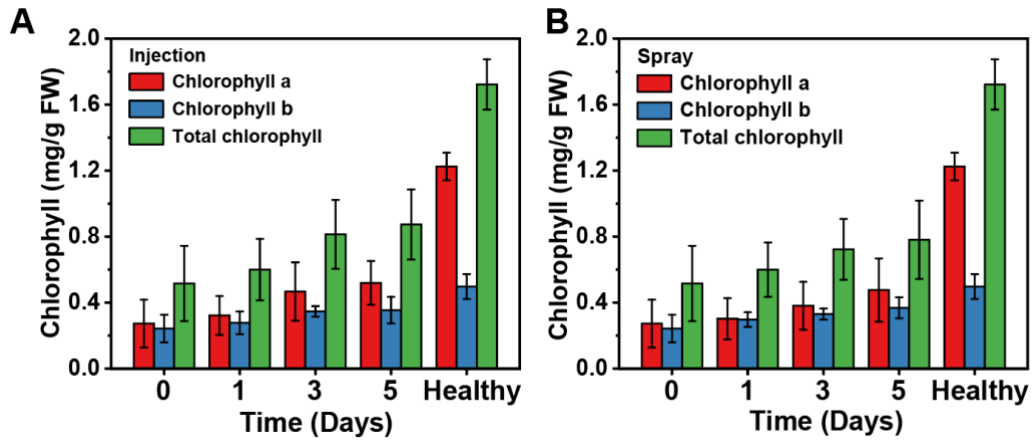
**Figure S2.** Characterization of the MONPs nano-enzyme. **(A)** Zeta potential analysis of the MONPs. **(B)** XRD (X-ray Powder diffractometer) pattern of the MONPs. **(C)** Raman pattern of the MONPs. **(D&E)** The fluorescence intensity of DCFH-DA after the reaction with X and XO in the absence and presence of the MONPs. X for xanthine and XO for xanthine oxidase, respectively. (Data are means, the statistic of peak points  $\pm$  SD,  $n=3$ ).



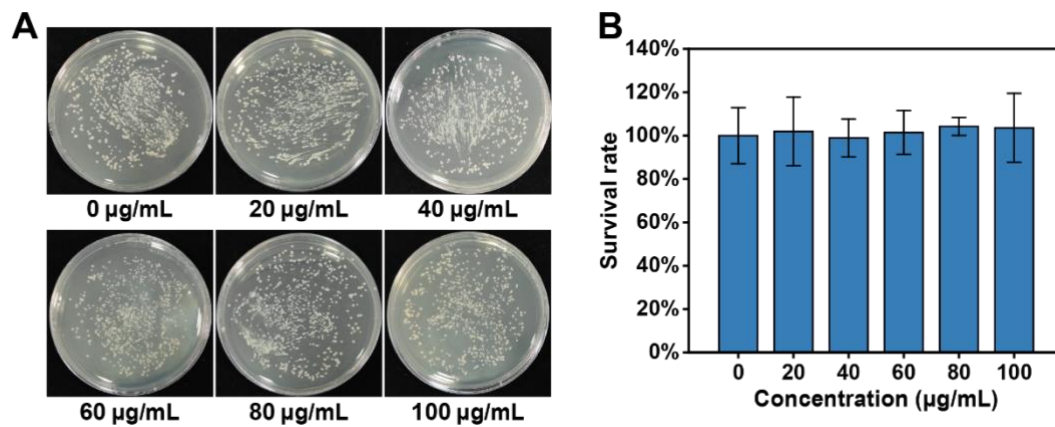
**Figure S3.** Confirm of the Clas-positive infection in HLB-*Citrus*. **(A)** PCR analysis of the genomic DNA of Clas in *Citrus* tissues. H1, H2, H3 means the healthy *Citrus*; S1, S2, S3 means the HLB-*Citrus*. **(B)** Representative TEM images of the Clas colonization in HLB-*Citrus*. Scale bar: 500 nm (right) and full size of 5  $\mu$ m (left).



**Figure S4.** Screen reactive oxygen species fluorescence probe for trace ROS localization in HLB-Citrus leaf. Scale bar: 20  $\mu\text{m}$ .



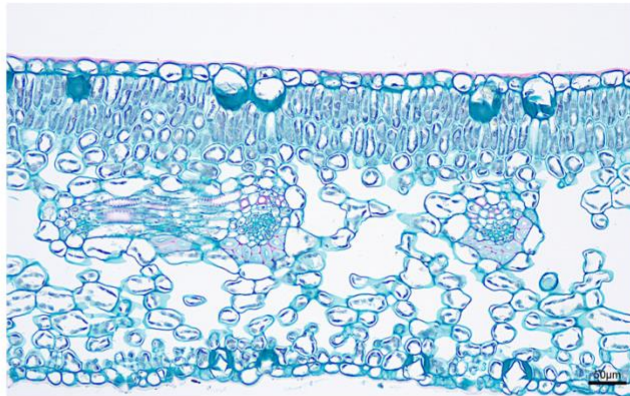
**Figure S5.** Effects of MONPs on the Chlorophyll content of HLB-Citrus (Data are means  $\pm$  SD, n=3).



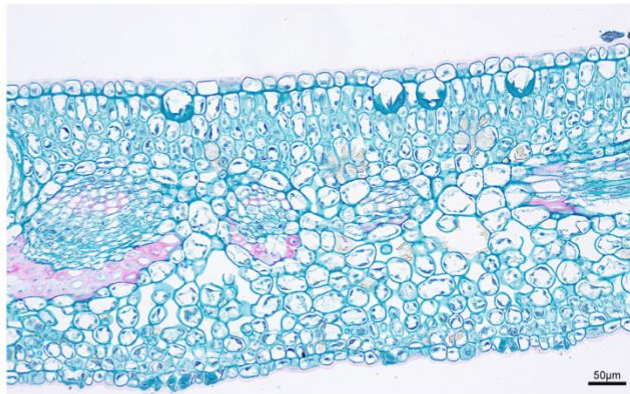
**Figure S6.** Assay of the *in vitro* antibacterial activity of MONPs. *Sinorhizobium meliloti Rm1021* (*S. meliloti Rm1021*) was co-incubated with MONPs at different concentrations (0, 20, 40, 60, 80, 100 µg/mL). **(A)** Representative images of the diluted coating plate; **(B)** Quantitative analysis of antibacterial activity of the MONPs against *S. meliloti Rm1021* (Data are means  $\pm$  SD, n=3).



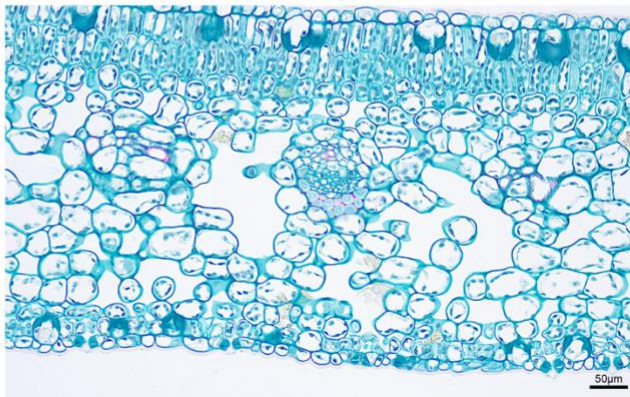
Healthy *Citrus*



HLB-*Citrus*



MONPs sprayed  
HLB-*Citrus*



**Figure S7.** Representative images of the *Citrus* leaf tissues staining with histochemical safranin O-fast green solution to observe the morphology.



**Figure S8.** GO enrichment histogram of top 30 GO function terms of HLB symptom related differentially expressed genes (DEGs).