Electronic Supplementary Material (ESI) for Environmental Science: Nano.

Supplementary information

Response mechanisms of photosynthesis in typical C3 and C4 plants upon La_2O_3 nanoparticle exposure

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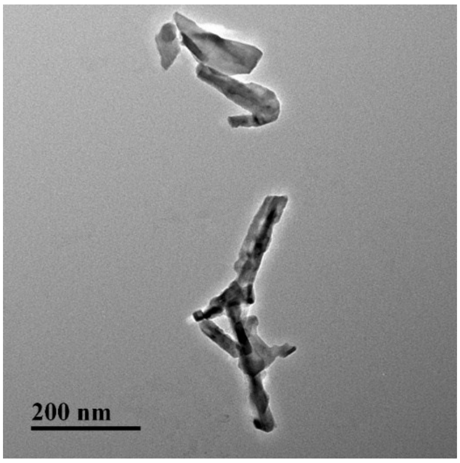

Fig. S1. Transmission electron microscopy (TEM) image of La_2O_3 NPs.

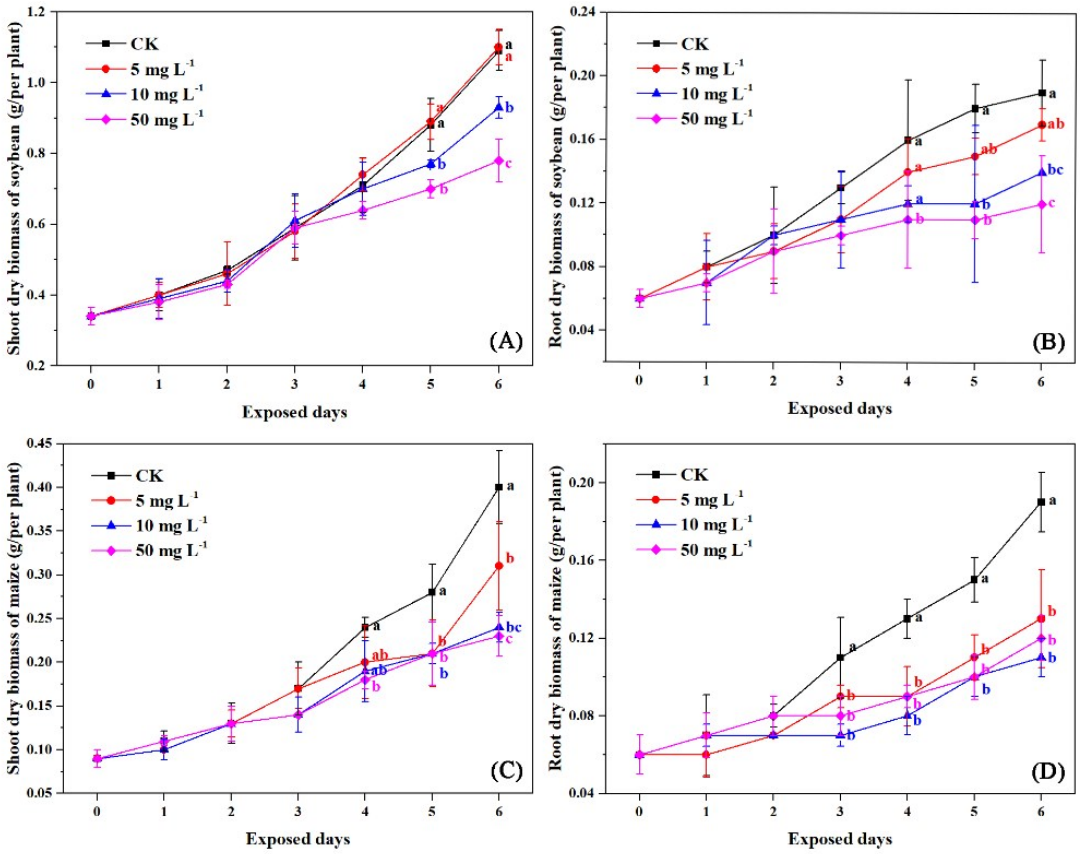

Fig. S2. The shoot and root growth curves of soybean (A and B) and maize (C and D) during 6-day La_2O_3 NPs exposure. Values represent mean ± SD (n = 6). Different letters indicate significant differences between the treatment means ($p < 0.05$). The letters are only showed when differences among means are statistically significant.

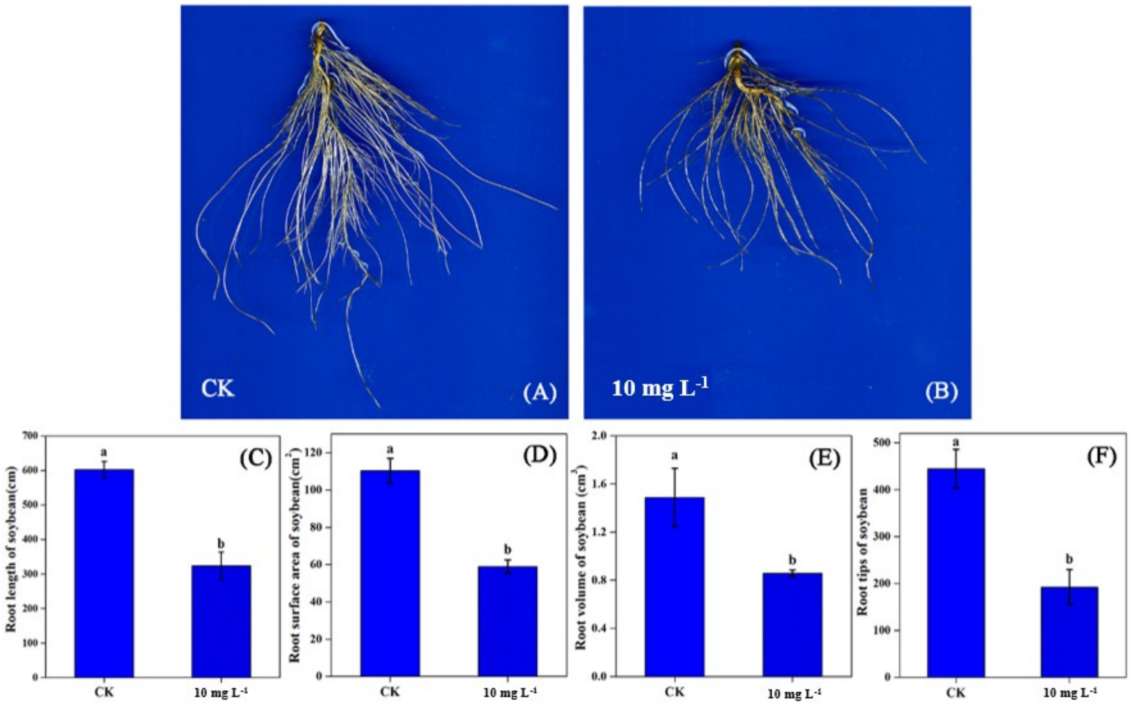

Fig. S3. Root morphology of soybean exposed La_2O_3 NPs (A: control, B: 10 mg L^{-1} La_2O_3 NPs exposure). And morphological parameters, including root length (C), surface area (D), volume (E) and root tips (F). Different letters indicate significant differences between the treatment means ($p < 0.05$).

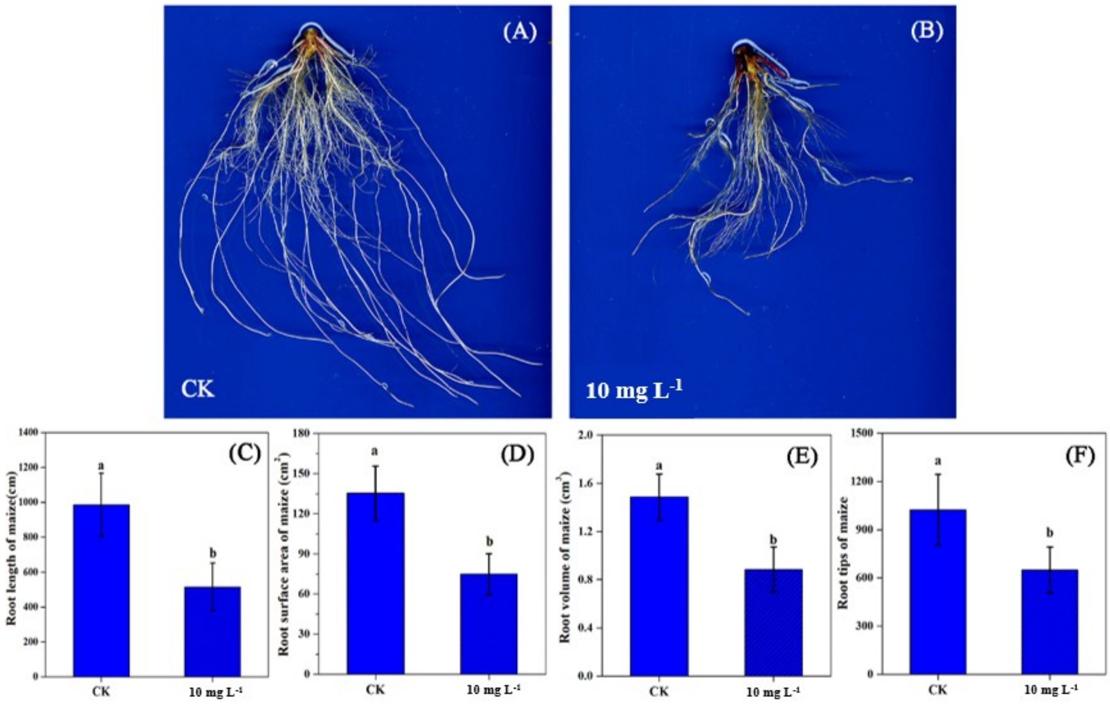

Fig. S4. Root morphology of maize exposed La_2O_3 NPs (A: control, B: 10 mg L^{-1} La_2O_3 NPs exposure). And morphological parameters, including root length (C), surface area (D), volume (E) and root tips (F). Different letters indicate significant differences between the treatment means ($p < 0.05$).

Table S1. The glossary of terms of chlorophyll a fluorescence parameters.[1]

Parameter	The description of chlorophyll a fluorescence parameters
ABS/RC	The light energy absorbed per unit reaction center (RC)
TRo/RC	Energy captured by the unit RC for Q_A reduction
DIo/RC	Energy dissipated per unit RC
ETo/RC	Energy captured by the unit RC for electron transport
ABS/CSm	The light energy absorbed per unit area, which is similar to Fm
TRo/CSm	The light energy captured per unit area for electron transport
DIo/CSm	Thermal energy dissipation per unit area
ETo/CSm	Quantum yield for electron transport per unit area
φ(Po)	Maximum photochemical efficiency, which is similar to Fv/Fm
φ(Eo)	Quantum yield for electron transport
φ(Do)	Quantum ratio for thermal energy dissipation
ψo	The efficiency of electron moves beyond Q_A^-
Sm	The energy required for Q_A reducing completely, which reflects the volume of PQ pool
N	The amount of reduction of Q_A, which indicates Q_A ability to electron transport
Mo	The initial slope of OJIP curve, which indicates the rate of Q_A reducing
PI_{abs}	Performance index for energy conservation

Table S2. The sequences of specific primers used for the qRT-PCR analysis.[2]

Accession no	Target gene	Primer sequences
X 15238	*ZmPEPc*, forward	5’- AGCCTTCAGAACCGATGAAATC -3’
	ZmPEPc, reverse	5’- CATCCCATAGCGCATTTCG -3’
Z 11973	*ZmRbcL*, forward	5′-AAAGCCTTACGCGCTCTACGT-3′
	ZmRbcL, reverse	5′-CGGACCTTGGAAAGTTTTTGAA-3′
D 00170	*ZmRbcS*, forward	5’-ATGTGGAAGCTGCCCATGTT-3’
	ZmRbcS, reverse	5’-GCCTCCTGCAGCTCCTTGTA-3’
J 01238	Aktin, forward	5’-GATGGTCAGGTCATCACCATTG-3’
	Aktin, reverse	5’-AACAAGGGATGGTTGGAACAAC-3’

References

1. R. J. Strasser, M. Tsimilli-Michael, S. Qiang and V. Goltsev, Simultaneous in vivo recording of prompt and delayed fluorescence and 820-nm reflection changes during drying and after rehydration of the resurrection plant *Haberlea rhodopensis*, *Biochim. Biophys. Acta*, 2010, **1797**, 1313-1326.
2. A. Sezgin, C. Altuntas, M. Demiralay, S. Cinemre and R. Terzi, Exogenous alpha lipoic acid can stimulate photosystem II activity and the gene expressions of carbon fixation and chlorophyll metabolism enzymes in maize seedlings under drought, *J. Plant Physiol.*, 2019, **232**, 65-73.