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


# Supplementary materials

# Response of primary root to nitrogen-doped carbon dots in *Arabidopsis thaliana*: Alterations in auxin level and cell division activity

### The procedure for the determination of the fluorescence quantum yields

Fluorescence quantum yields of the N-CDs were obtained by using the comparative method. The quantum yield of N-CDs, Φ x, is calculated according to the following equation:

$$\Phi_x = \Phi_{std}\left(\frac{F_x}{F_{std}}\right)\left(\frac{A_{std}}{A_x}\right)\left(\frac{n_x}{n_{std}}\right)^2$$

Where Φ, F, A, and n are quantum yield, integral of the fluorescence emission scan, absorbance, and refractive index, respectively. The subscript “x” denotes the type of sample to be analyzed (i.e., N-CDs). The subscript “std” refers to the standard fluorophore of known quantum yield, for an example, quinine sulfate used in present work (The quantum yield of quinine sulfate dissolved in 0.1 M H2SO4 is 0.54.).

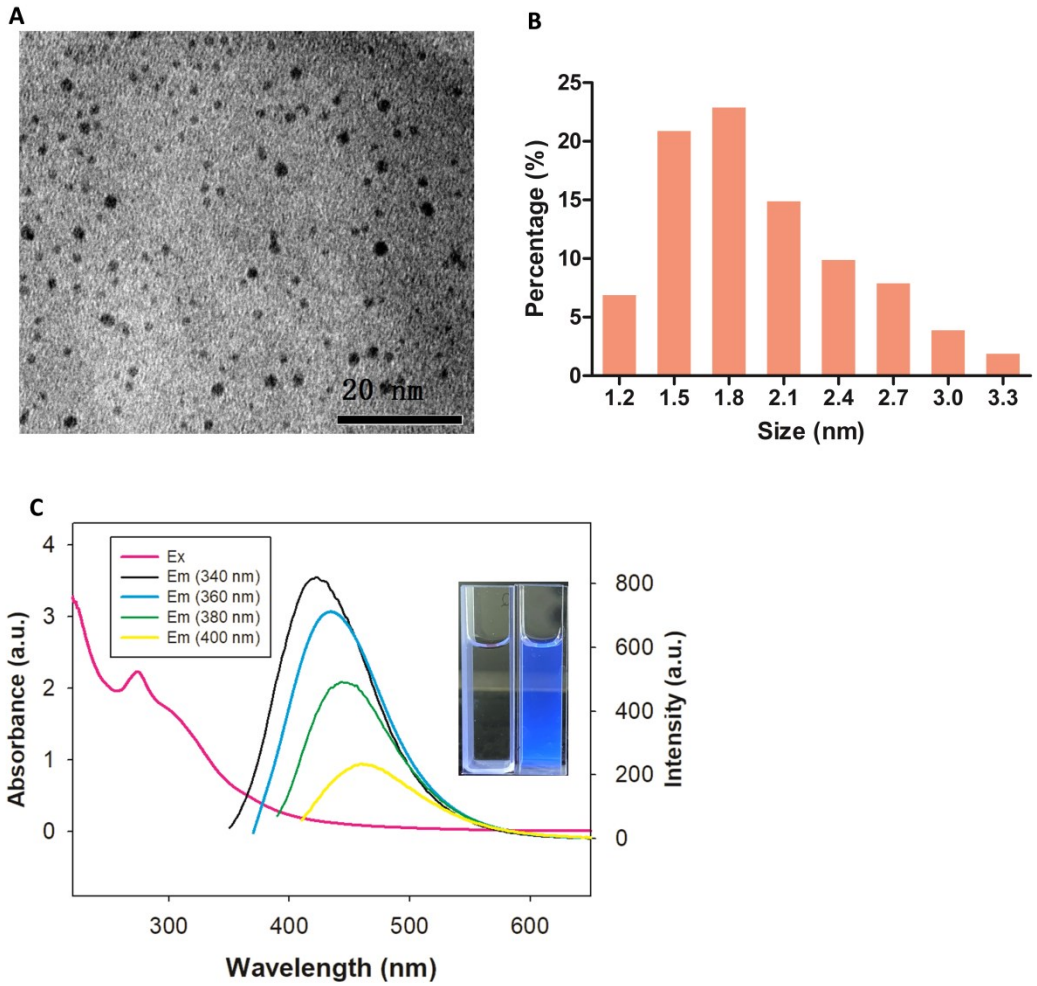


**Figure S1.** The morphology and characterization of N-CDs. **(A)** TEM image of N-CDs. **(B)** Size frequency distribution of N-CDs. **(C)** UV/Vis absorption and PL spectra of N-CDs at different excitation wavelengths (inset: pure water (left) and N-CDs aqueous solution (right) under UV irradiation (365nm)).

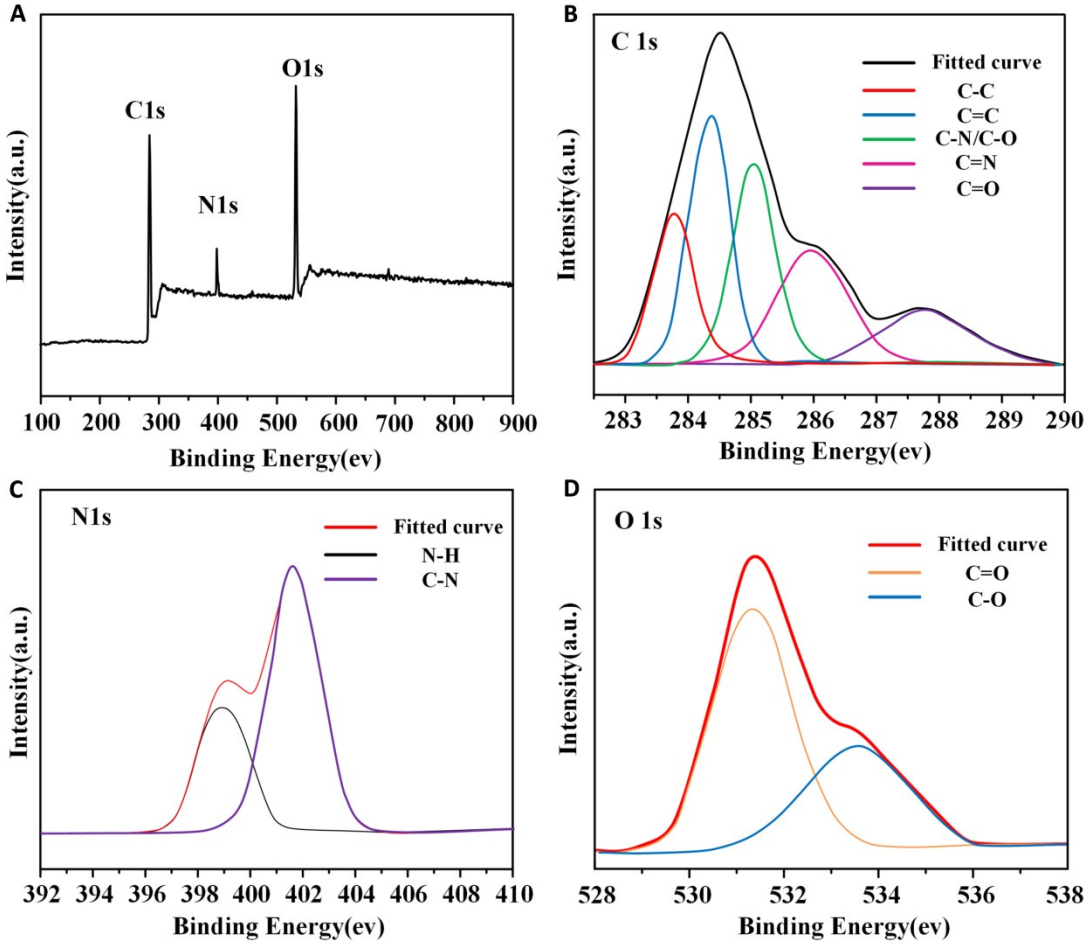


**Figure S2. (A)** XPS spectrum and high resolution XPS spectra of **(B)** C 1s, **(C)** N 1s and **(D)** O 1s of the N-CDs.

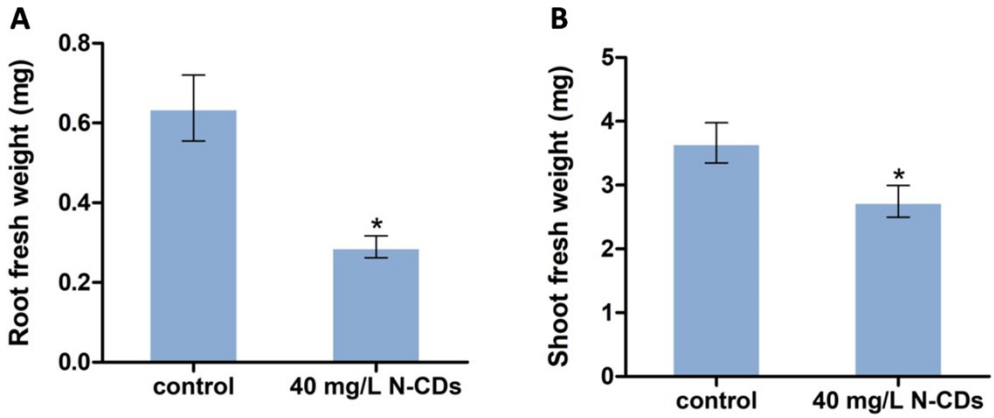


**Figure S3.** The effects of N-CDs on fresh weights of different *Arabidopsis* parts.**( A)** The fresh weight of the *Arabidopsis* root after 4 days of incubation. **(B)** The fresh

weight of the *Arabidopsis* shoot after 4 days of incubation. The values were given as the mean ± SD of triplicate samples. Asterisks represent significant difference at $p < 0.05$ compared to the control.

**Table S1. Primers for qRT-PCR.**

| Gene name | Forward | Reverse |
|---|---|---|
| *YUC2* | CAAGATCAAATGCGGAAAGACT | CCGAATAATGCATTACCCGTTT |
| *YUC3* | ATGATGAGACGTTCGGGCTG | CGTTGCCACCACAATCCATC |
| *YUC5* | TCTGGCGCATCAAGACAACA | TCACCTCGCCTTCAAACTCC |
| *YUC9* | CTCGTAGATGGTCAGAAGCTAG | AATGTCTTGAGCGATGTTAACG |
| *SUR1* | GAGATCTTCCGCACAAGTTAAC | CAATGGCTTCGATACCTTCAAG |
| *CYP79B2* | GAAAGTTGTGATGACGGAACTC | GCATTTCCACAGTAATGCCTAG |
| *AMI1* | TCTGAACTGATAACGGCTCTTT | AAAACCGTCTGAGCCATACTTA |
| *ASA1* | CTCTGAGAAATGGAACCCTGAT | ATGCTTTCTTTTCCACGTGATC |
| *Histone4* | GATTCGTCGTCTTGCTCGTAG | CAGTCACCGTCTTCCTCCTC |
| *E2Fa* | ACCATCCACCGTCATCTC | GCTCCTGTCGTTATTATTACTG |
| *CYCB1;1* | CTCAAAATCCCACGCTTCTTGTGG | CACGTCTACTACCTTTGGTTTCCC |
| *WEE1* | TGGTGCTGGACATTTCAGTCGG | CAAGAGCTTGCACTTCCATCATAG |
| *CDC25* | GCTCGTTTGATGACAAGATCTC | GCGTTCCAAGATCATGATGTTT |
| *WOX5* | TCTCCGTGAAAGGTCGAAGC | GGAGTTCTAAGACCGGCTCG |
| *MSH2* | TCTGACTAGGCGAGTTCTT | CACCTCTCCAGGGAATCA |
| *MSH6* | ATTAGTTAGAAAGGGCTATCGGG | AACAACTGCACATACTTCGC |